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Technical Report 537

DESIGN GUIDELINES AND CRITERIA FOR USER/OPERATOR TRANSACTIONS WITH BATTLEFIELD AUTOMATED SYSTEMS

VOLUME IV: PROVISIONAL GUIDELINES AND CRITERIA

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U. S. Army
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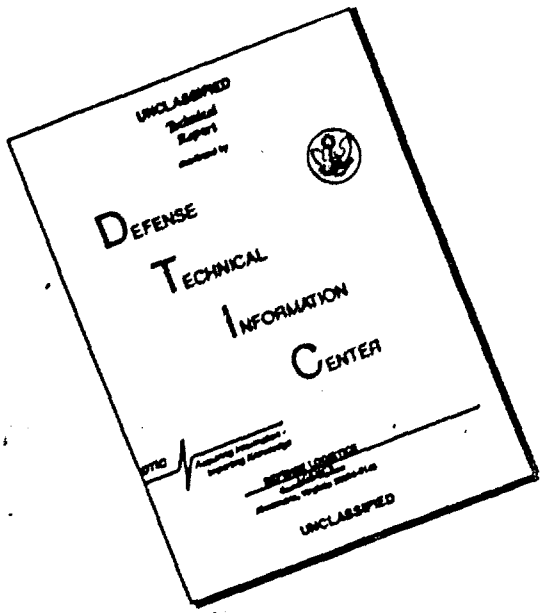

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This document is one of a series in the Final Report of Phase I in a project to develop design guidelines and criteria for user/operator transactions with battlefield automated systems. The report is organized in five volumes as follows:

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Item 20 (Cont'd)

I. Executive Summary (RR 1320)
II. Technical Report (TR 536)
III. In-Depth Analyses of Individual Systems
  A. Tactical Fire Direction System (TACFIRE) (RP 81-26)
  B. Tactical Computer Terminal (TCT) (RP 81-27)
  C. Admin/Log Automated Systems (RP 81-28)
  D. Intelligence Information Subsystem (IISS) (RP 81-29)
IV. Provisional Guidelines and Criteria (this report)
V. Background Literature (TR 538)

Volume I presents a succinct review of activities and products of the project's first phase. Volume II contains a technical discussion of the project's objectives, methodologies, results, conclusions, and implications for the design of user/operator transactions with battlefield automated systems. Volume III documents analyses of four unique battlefield automated systems selected to represent different stages of system development and different Army functional areas. Volume IV presents provisional guidelines and criteria for the design of transactions. Volume V provides a brief review of selected literature related to guidelines and criteria.

Technical Report 537

DESIGN GUIDELINES AND CRITERIA FOR USER/OPERATOR TRANSACTIONS WITH BATTLEFIELD AUTOMATED SYSTEMS VOLUME IV: PROVISIONAL GUIDELINES AND CRITERIA

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Human Performance Effectiveness
and Simulation

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FOREWORD

The Human Factors Technical Area of the Army Research Institute (ARI) is concerned with helping users and operators cope with the ever increasing complexity of the battlefield automated systems by which they acquire, transmit, process, disseminate, and utilize information. Increased system complexity increases demands imposed on the human interacting with the machine. ARI's efforts in this area focus on human performance problems related to interactions with command and control centers, and on issues of system design and development. Research is addressed to such areas as user-oriented systems, software development, information management, staff operations and procedures, decision support, and systems integration and utilization.

An area of special concern in user-oriented systems is the improvement of the user-machine interface. Lacking consistent design principles, current practice results in a fragmented and unsystematic approach to system design, especially where the user/operator-system interaction is concerned. Despite numerous design efforts and the development of extensive system user information over several decades, this information remains widely scattered and relatively undocumented except as it exists within and reflects a particular system. The current effort is dedicated to the development of a comprehensive set of Human Factors guidelines and evaluation criteria for the design of user/operator transactions with battlefield automated systems. These guidelines and criteria are intended to assist proponents and managers of battlefield automated systems at each phase of system development to select the design features and operating procedures of the human-computer interface which best match the requirements and capabilities of anticipated users/operators.

Research in the area of user-oriented systems is conducted as an in-house effort augmented through contracts with uniquely qualified organizations. The present effort was conducted in collaboration with personnel from Synectics Corporation under contract MDA903-80-C-0094. The effort is responsive to requirements of Army Project 2Q263744A793, Human Performance Effectiveness and Simulation, and to special requirements of the U.S. Army Combined Arms Combat Developments Activity (CACDA), Fort Leavenworth, Kansas.

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Technical Director

DESIGN GUIDELINES AND CRITERIA FOR USER/OPERATOR TRANSACTIONS WITH BATTLEFIELD AUTOMATED SYSTEMS VOLUME IV: PROVISIONAL GUIDELINES AND CRITERIA

EXECUTIVE SUMMARY

Requirement:

To develop a comprehensive set of human factors guidelines and criteria for the design of user/operator transactions in battlefield automated systems for use by human factors specialists and system proponents, managers, and developers.

Procedure:

To provide data for a baseline functional description of user/operator transactions in battlefield automated systems, user/operator interactions in a series of systems were analyzed using a Transaction Feature Analysis technique. Data were collected during interviews with system experts and reviews of system documentation. Transactions were then compared across systems using a Transaction Compatability Analysis technique. Results of these analyses formed the data base for development of preliminary guidelines and criteria.

Findings:

An initial output of the preliminary review of systems was the following categorizaton of design features affecting user/operator transactions with battlefield automated systems: Control Methods, Display Formats, Data Entry Assistance, Message Composition Aids, Data Retrieval Assistance, Glossaries, and Error Handling Techniques. Appropriate subcategories were established for each of the major design feature categories. Provisional guidelines were prepared for the following selected design feature topics: Command Methods for Alphanumeric Terminals, Selective Highlighting, and Information on Legal Entries. Guidelines sets are organized around the following topics: Definition, Use, Applications, Types, Recommendations, and Advisory Comments. In addition, discussions are presented about each of the 34 subcategories of design features.

Utilization of Findings:

Findings from the analysis of individual systems may be useful to proponents in specifying user/operator requirements for future system evolution. In this project, the findings were incorporated in a data base on human factors requirements which provided the "real world" foundation for development of the provisional guidelines and criteria presented in volume IV of this report. The provisional guidelines and criteria will be utilized as the basis for development of the prototype handbook.

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INTRODUCTION

This report documents progress towards specification of guidelines and criteria for user/operator transactions with U.S. Army battlefield automated systems. The categories in which guidelines and criteria are being developed are listed in Table 1. This structure for organizing guidelines differs somewhat from that included in other volumes of this report since it reflects lessons learned from detailed human factors analyses of existing Army systems.

Discussions of each subcategory are presented in the main body of this report. These discussions suggest the thrust of future guideline preparation, organized in five topical areas:

I. AREAS OF APPLICATION: suggests the situations in which design methods in the category might be applied.

II. METHODS: lists the specific design methods which might be used to provide the interactive capabilities implied by the category title.

III. FACTORS INFLUENCING APPLICABILITY: identifies conditions and situations which affect the selection of particular design methods.

IV. CRITERION AREAS: describes the ways in which design methods would affect user/operating performance in interacting with Army battlefield automated systems.

V. GUIDELINES: presents design information organized as follows:

1. DEFINITION: specifies the role of the design feature in human-computer interaction.

2. USE: indicates why a design feature in the category might be used to enhance user/operator performance with battlefield automated systems.

3. APPLICATIONS: describes some of the important situations in which the design feature might be employed. Each application description includes an example of processes which might be encountered in Army battlefield automated systems.

Table 1

Categories of User/Operator Transactions with Battlefield Automated Systems

1. COMMAND METHODS
   - 1.1 Alphanumeric Command Methods
   - 1.2 Graphic Command Methods
   - 1.3 Prompts/HELPS
   - 1.4 Hybrid Methods

2. DISPLAY FORMATS
   - 2.1 Fixed Format Alphanumeric Displays
   - 2.2 Variable Alphanumeric Displays
   - 2.3 Graphic Displays
   - 2.4 Selective Highlighting

3. DATA ENTRY ASSISTANCE
   - 3.1 Information on Legal Entries
   - 3.2 Unburdening of Input
   - 3.3 Interrupts and Work Recovery

4. MESSAGE COMPOSITION AIDS
   - 4.1 Format for Alphanumeric Messages
   - 4.2 Graphic Messages

5. DATA RETRIEVAL ASSISTANCE
   - 5.1 Query Method
   - 5.2 Query Structure

6. GLOSSARIES
   - 6.1 Standard Terms
   - 6.2 Character Sets and Labels
   - 6.3 Glossary Availability and Use
   - 6.4 Abbreviation and Coding

7. ERROR HANDLING
   - 7.1 Prevention
   - 7.2 Detection
   - 7.3 Feedback
   - 7.4 Correction/Recovery

8. USER/OPERATOR CONFIGURATIONS

4. TYPES: describes the ways in which particular design methods might be applied to user/operator interaction with Army battlefield automated systems. Where appropriate, examples of these design methods are provided. The examples reflect implementations which might actually appear in battlefield automated systems.

5. RECOMMENDATIONS: presents recommendations for the situations in which design methods should be employed in particular application areas. Recommendations are presented in tables which rate methods with respect to their general utility in the applications listed.

6. ADVISORY COMMENTS: discusses special factors which affect the utility of particular design methods in particular applications or under special circumstances. Environmental, system hardware, system software, and other factors which might influence the success of the implementation of the method are discussed.

Three sets of provisional guidelines have been generated to date:

1. Area 1.1: Command Methods for Alphanumeric Terminals.

2. Area 2.4: Selective Highlighting.

3. Area 3.1: Information on Legal Entries.

In the second phase of the project, the set of provisional guidelines will be greatly expanded and enhanced to address all of the categories and subcategories of user/operator transactions with battlefield automated systems represented in Table 1.

SECTION 1. COMMAND METHODS

Guidelines in this category deal with methods for allowing users/operators to control the processes of the hardware and software components of the system. When completed, the guidelines will discuss what methods (or combinations of methods) are most appropriate for given combinations of user types, hardware and software characteristics, and environmental factors. Four aspects of command methods are considered:

1.1 Alphanumeric Command Methods, characterized by a requirement for the user/operator to learn and apply a language which the system "understands."

1.2 Graphic Command Methods, techniques employing imagery, symbology, and pictorial representaiton by which users/operators may define desired system operations.

1.3 Prompts/HELPS, methods for presenting information and instruction to the user/operator which "cue" system operation.

1.4 Hybrid Methods, combining two or more of the methods described above.

1.1 ALPHANUMERIC COMMAND METHODS

I. Areas of Application for Alphanumeric Command Methods.

1. Controlling the operation of ADP systems.

II. Methods for Entering Alphanumeric Commands.

1. Question and answer dialog.
2. Form filling.
3. Fixed function keys.
4. Variable function keys.
5. Menu selection.
6. Light pen dialog.
7. Cursor positioning.

8. User-initiated command languages.

9. Natural language dialogs.

10. Voice input.

III. Factors Influencing the Applicability of Alphanumeric Command Methods.

1. Experience of the users/operators.

2. Variability of experience among the users/operators.

3. Number of commands in the ADP system.

4. Number of times an average command is used in the ADP system.

5. Computer-to-terminal data transmission rate.

6. Availability of HELP information at the user terminal.

7. Level of noise in the environment in which system interactions take place.

IV. Criterion Areas for Alphanumeric Command Methods.

1. Error rates, as influenced by:

a. Probability of error in specification of command string.

b. Error associated with recall of commands.

c. Errors associated with carrying the command structure in short-term memory after viewing HELP files.

d. Entry of non-disambiguable command strings.

e. Inherent error rate of command interpretation.

f. Errors due to fatigue on the part of users/operators.

2. System throughput rates, as influenced by:

a. Time required to enter commands.

b. Time required to look up command meanings, content, and/or formats in system reference documentation.

c. Time required to access command HELP files.

d. Time required to re-enter invalid commands.

e. Time required to re-orient hands and eyes when using behaviorally conflicting command modes.

3. Other criterion areas:

   a. User frustration at amount of reference to system documents required.

   b. User frustration at amount of time spent entering default of sequence continuation commands or characters.

V. Guidelines for Alphanumeric Command Methods

1. Definition: alphanumeric commands are dialog types by which users/operators communicate their directions to the computer through the computer terminal.

2. Use: selection of a good dialog type will make it easier for the user/operator to indicate to the computer system what operations are to be performed.

3. Applications: selection of dialog type depends on the nature of the system being developed and the characteristics of the expected users/operators of the system. Some of the most important factors in making this decision are:

   a. Sophistication of the users/operators.

      (1) HIGH level of sophistication means that users/operators are very familiar with the system, its capabilities, and the sequences of operations which the system will perform. Users/operators with a HIGH level of sophistication will have either (a) received a substantial amount of training in system operation or (b) had considerable experience in operating the system by the time they are called on to use it in operational situations.

      (2) MEDIUM level of sophistication means that users/operators are quite familiar with the most important capabilities and commands of the system, but are not intimately familiar with little-used system features. Users/operators with a MEDIUM level of sophistication may have received considerable training, but will not use the system enough to maintain their knowledge about all of the system's capabilities.

      (3) LOW level of sophistication means that users/operators are familiar only with the "big picture" of system operation. They may be unfamiliar with the range of capabilities of the system.

      (4) VARIABLE level of sophistication means that different users/operators have different levels of sophistication in using the system. Some may be very familiar with its features and capabilities, while others will be aware of only the most elementary and important features.

b. Number of Commands

(1) VERY HIGH--more than 300 separate commands and command options.

(2) HIGH--151 to 300 separate commands and command options.

(3) MEDIUM--50 to 150 separate commands and command options.

(4) LOW--50 or fewer separate commands and command options.

c. Number of times an average command will be used by a typical user/operator in a given period of time.

(1) HIGH--average command used 5 times per day or more.

(2) MEDIUM--average command used twice per week or more but less than 5 times per day.

(3) LOW--average command used less than twice per week.

d. Computer-to-terminal data transmission rate.

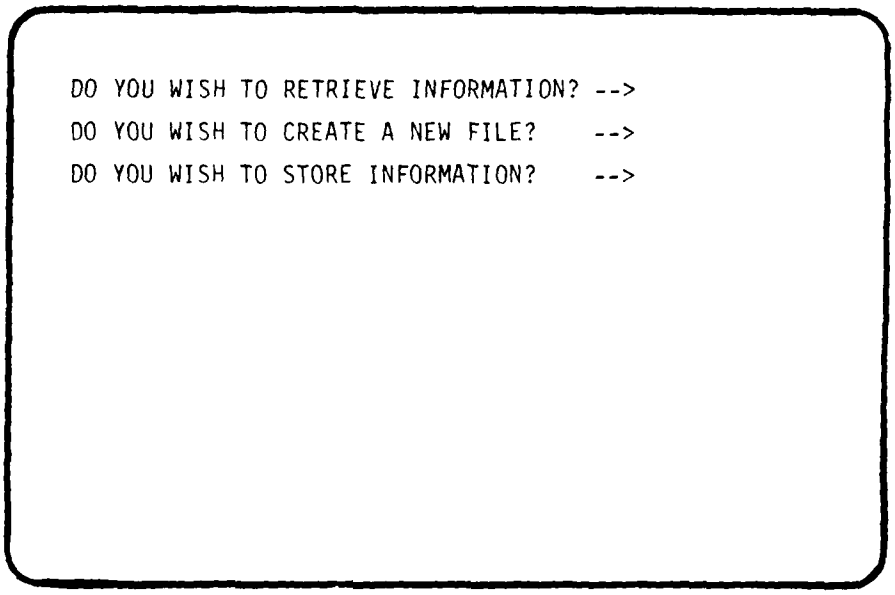
(1) HIGH--500 baud (400 characters per second) or greater.

(2) MEDIUM--1500 baud (150 characters per second) or greater, but less than 4000 baud (400 characters per second).

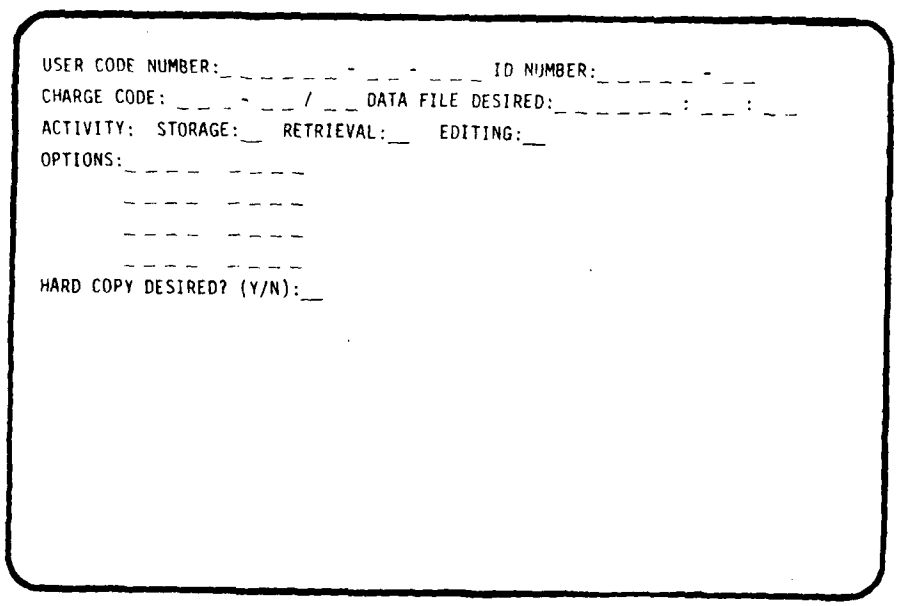
(3) LOW--less than 1500 baud (150 characters per second).

4. Types of Alphanumeric Dialog:

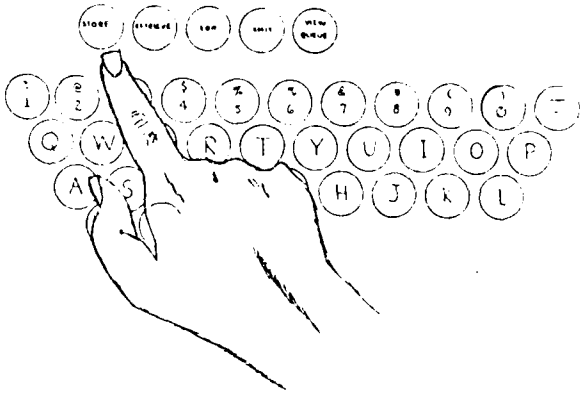
a. Question and answer dialog, in which the computer system asks the user/operator specific questions. In the simplest form of this type of dialog, the user/operator may respond only with "Y(ES)" or ("N(O)." In more complex forms, the user/operator may be required to respond with a number or a code for a command.



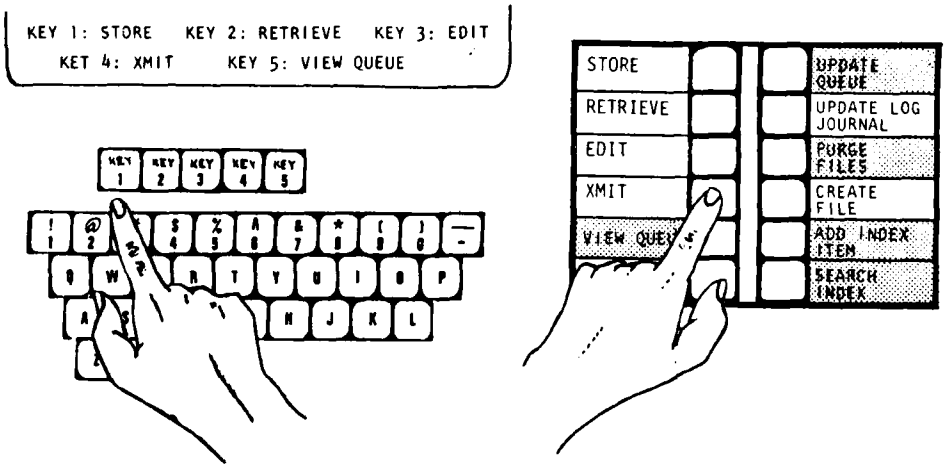
b. Form filling, in which the user/operator fills out a form or questionnaire presented at the terminal. The entries in the "blanks" may be words, codes, numbers, or merely symbols ("checkmarks" or "Xs") to indicate that the user/operator wishes to perform the operation displayed on the "form."



c. Fixed function keys, in which the user/operator presses a special key on a terminal keyboard to indicate to the computer that a particular operation should be performed. The keys are labeled with the operations which the system is to perform.



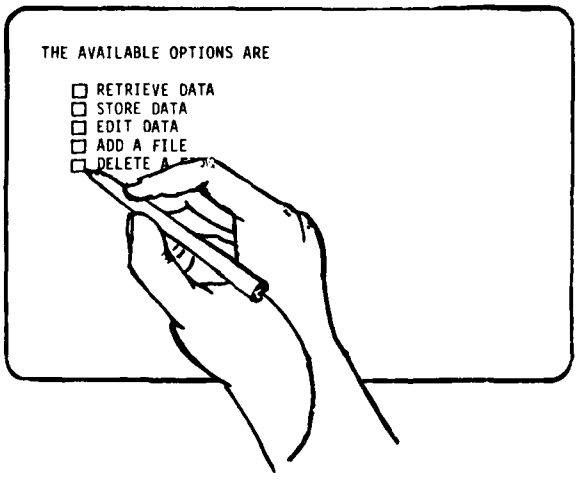
d. Variable function key dialogs, in which the user/operator presses a special key to indicate to the computer system that a particular operation should be performed. The variable function key may perform different functions, depending on what kind of activity the user/operator is performing. Usually the specific effect of pressing a given variable function key is indicated by a brief menu presented on the terminal or on transparent key label overlays or underlays.



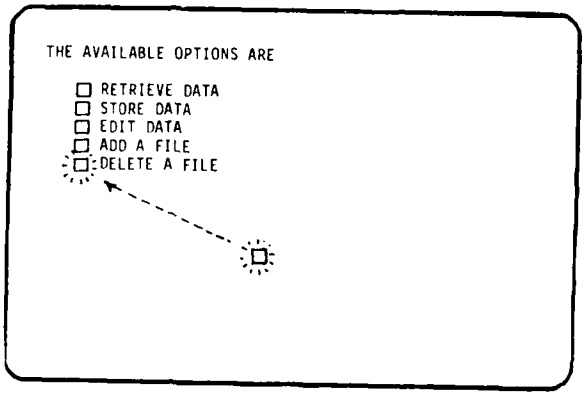
e. Menu selection, in which the user/operator selects a desired command from a list of commands presented on the display. The user/operator then enters the code, word, or number associated with that command.

```
THE AVAILABLE OPTIONS ARE:

    1. (RE)TRIEVE DATA
    2. (ST)ORE DATA
    3. (ED)IT DATA
    4. (AD)D A FILE
    5. (DE)LETE A FILE




ENTER DESIRED OPTION -->
```

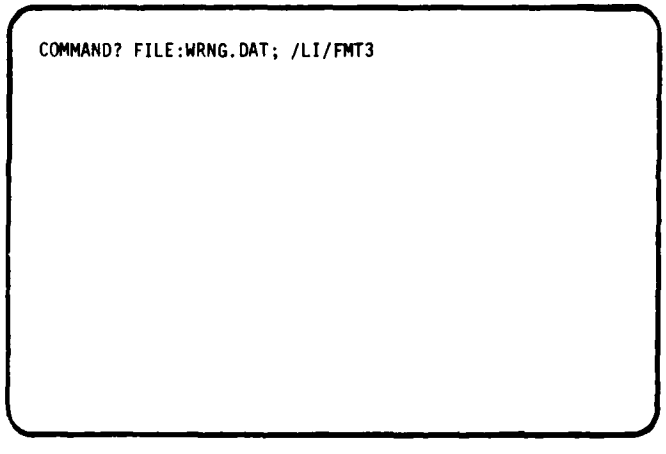
f. Light pen dialogs, which are usually a special form of menu dialog in which the user/operator touches a light pen to the option that identifies the command which the user/operator desires.



g. Cursor control dialogs, which are usually a special form of menu dialog, in which the user/operator positions the screen cursor next to the desired command. The cursor may be moved with any graphic positioning device. In the example below, the user/operator is using a joystick.



h. User-initiated command language dialogs, in which the user/operator enters commands in response to a prompt symbol appearing on the terminal. The prompt is typically brief, so the user/operator must remember the command codes and options and accurately type them at the terminal.



i. Natural-language dialogs, which are typically user-initiated command languages, in which the designer attempts to make the command language as much like standard English as possible.

```
COMMAND?  PRINT THE FILE CALLED WRNG.DAT USING
          FORMAT NUMBER THREE
```

j. Voice inputs, which are typically a form of user-initiated command language, where the user/operator speaks commands instead of typing them.

5. Recommendations: Table 2, Dialog Type by System and System User Characteristics, presents a general list of recommendations for selecting dialog types. Before making a final decision on dialog type, be sure to consult the specific recommendations for individual dialog types beginning on page 16. You should also review the guidelines for "Hybrid Command Types" beginning on page 22.

To use the table, first decide what system and system user characteristics apply to the situation you are considering. Eliminate any dialog types where a "4" appears as an entry. Select the best dialog type by comparing the remaining types in view of the type of system you are conceptualizing or designing.

Table 2

Dialog Type by System and System User Characteristics

1 = BEST 2 = SECOND CHOICE 3 = WORKABLE BUT SUBOPTIMUM 4 = NOT RECOMMENDED	CHARATERISTIC OF SYSTEM OR SYSTEM USER													
	SOPHISTICATION OF USERS				NUMBER OF COMMANDS				EMPLOYMENT OF AVERAGE COMMAND			COMPUTER TO TERMINAL DATA TRANSMISSION RATE		
	HIGH	MEDIUM	LOW	VARIABLE	VERY HIGH	HIGH	MEDIUM	LOW	HIGH	MEDIUM	LOW	HIGH	MEDIUM	LOW
QUESTION AND ANSWER DIALOG	4	3	2	3	4	4	3	1	3	2	1	1	2	3
FORM FILLING	3	3	2	2	4	4	2	1	2	2	2	1	2	4
FIXED FUNCTION KEYS	1	1	1	1	4	4	4	1	1	2	3	1	1	1
VARIABLE FUNCTION KEYS	1	2	2	2	3	3	2	1	1	2	3	1	1	1
MENU DIALOG	2	1	1	1	2	2	1	1	3	2	1	1	2	4
LIGHT PEN DIALOG	4	3	1	2	3	3	2	1	4	3	1	1	2	4
CURSOR CONTROL DIALOG	4	3	1	2	3	3	2	1	3	2	2	1	2	4
USER-INITIATED COMMAND LANGUAGE	1	2	3	3	1	1	2	2	1	2	4	1	1	1
NATURAL LANGUAGE DIALOG	4	3	2	2	2	2	3	3	2	1	2	1	1	1
VOICE INPUT	2	2	2	2	3	2	1	1	1	2	3	1	1	1

6. Advisory Comments:

a. Question and Answer Dialogs

(1) USE QUESTION AND ANSWER DIALOGS only when the users/operators are likely to be VERY UNSOPHISTICATED in using system capabilities.

(2) USE QUESTION AND ANSWER DIALOGS when the user/operators are required to provide only "YES" or "NO" answers to questions generated by the computer systems.

(3) USE QUESTION AND ANSWER DIALOGS when the user/operator is required to enter information which cannot be placed on a list or easily encoded (e.g., time other than current time; number of troops).

(4) When using QUESTION AND ANSWER DIALOGS, provide examples of required command format and content whenever possible.

b. Form Filling

(1) USE FORM FILLING when the user/operator is typing in commands which have been written or typed previously on a hard copy form.

(2) When using FORM FILLING, provide a convenient means to control cursor movement from FIELD-TO-FIELD as well as from LINE-TO-LINE and CHARACTER POSITION-TO-CHARACTER POSITION.

(3) When the user/operator is using FORM FILLING to enter commands written or typed on hard copy, make the image of the form displayed on the CRT screen look as much like the hard copy form as possible.

(4) Avoid using FORM FILLING when the system must handle multiple form types and the computer-to-terminal data transmission rate is low. (In this situation, it will take too long to display the different forms when the user/operator must shift from form-to-form.)

c. Fixed Function Keys

(1) USE accurately labeled FIXED FUNCTION KEYS when user/operators are likely to be very unsophisticated in the use of computer systems and the command set is small.

(2) Group FIXED FUNCTION KEYS by purpose, type of data involved, etc.

(3) If FIXED FUNCTION KEYS are enabled only at certain points during system operations, and are disabled at other times, provide a light behind each key which is ON when the key is ENABLED.

d. Variable Function Keys

(1) When a constant set of commands is available at all points in system operation, place these commands on the same VARIABLE FUNCTION KEYS throughout system operation. (Note: from the standpoint of the user, these become FIXED FUNCTION KEYS.)

(2) As much as possible, place command labels on, in, or beside VARIABLE FUNCTION KEYS rather than listing options in menu form on the display and numerically or alphanumerically encoding the function keys.

(3) Where long-term usage of a particular VARIABLE FUNCTION KEY configuration is likely, provide key caps or other labeling overlays/underlays to differentiate VARIABLE FUNCTION KEY labels.

(4) Where different users/operators use the same terminal and system for different purposes, provide each user/operator with a set of overlays/underlays to designate the commands associated with particular VARIABLE FUNCTION KEYS for his or her particular application.

e. Menu Dialog

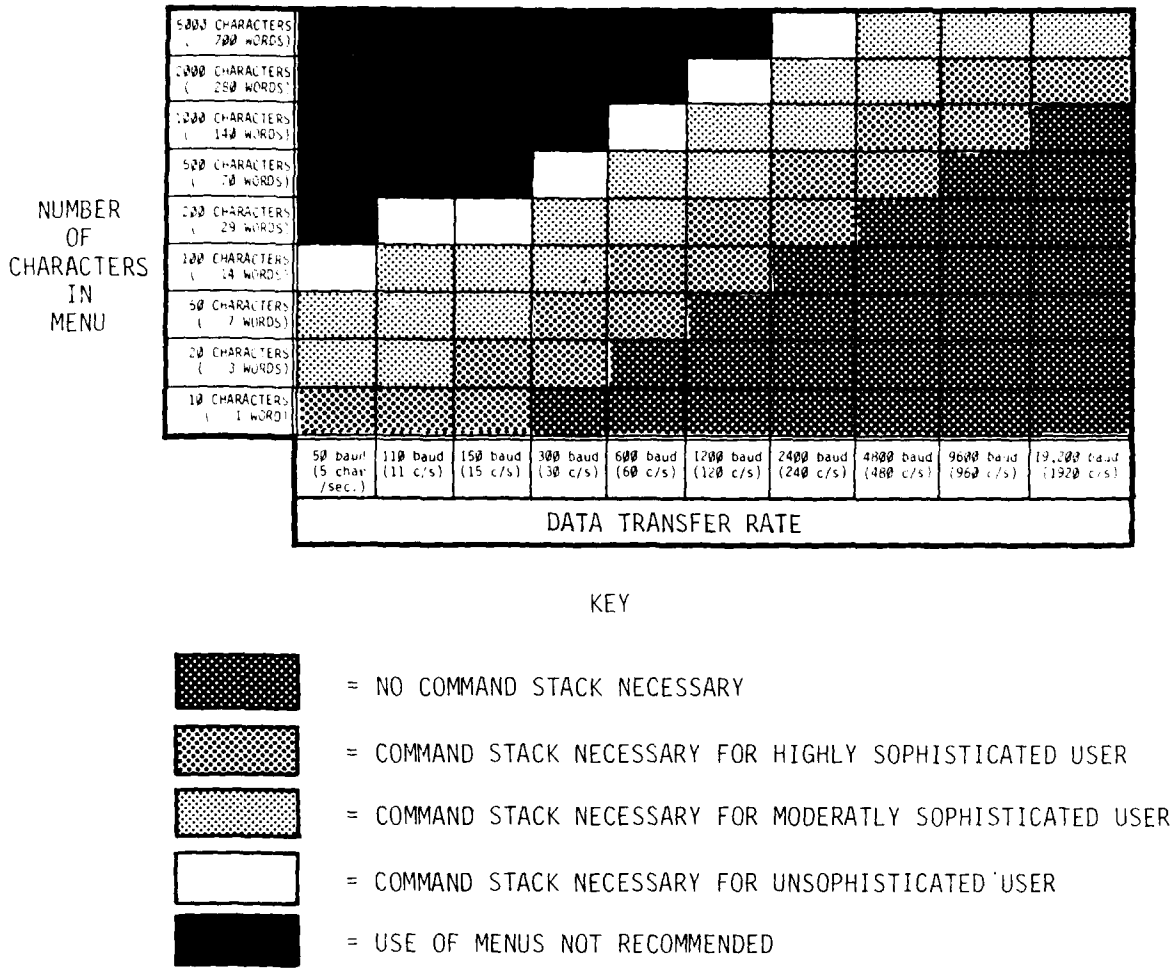
(1) USE MENU DIALOGS when the command set is so large that users/operators are not likely to be able to commit all commands to memory.

(2) Where there are logical relationships among commands, present groups of MENUS in a sequence which are in accordance with those logical relationships. For example, where commands are hierarchical, arrange the MENUS in a sequence from general to specific command formulation.

(3) USE MENU DIALOGS where at least some of the users/operators may not be familiar with all of the functions of the system.

(4) Where there is a wide difference in the sophistication of the set of expected user/operators, present MENUS of different levels of detail.

(5) Where some of the users/operators are (or will become) very sophisticated in system operation, provide a method for bypassing MENU DISPLAYS by stacking commands (that is, entering a whole set of commands in anticipation of upcoming displays). This recommendation is particularly important where the data transmission rate available will require that the time to display the menu will exceed 2 seconds. (See Figure 1.)



KEY

= NO COMMAND STACK NECESSARY

= COMMAND STACK NECESSARY FOR HIGHLY SOPHISTICATED USER

= COMMAND STACK NECESSARY FOR MODERATLY SOPHISTICATED USER

= COMMAND STACK NECESSARY FOR UNSOPHISTICATED USER

= USE OF MENUS NOT RECOMMENDED

Figure 1. Requirements for Command Stack Given Various Combinations of Characters in Menus and Data Transmission Rates.

f. Light Pen Dialog

(1) USE A LIGHT PEN DIALOG in systems where the user/operators are likely to be unfamiliar with the commands and functions of the system.

(2) When using LIGHT PEN DIALOG, make certain that the "targets" for the light pen are at least 1/4" square.

(3) If the user/operator is to use the LIGHT PEN for more than 1/4 hour continuously, place the display screen in a horizontal or nearly horizontal position so that the user/operator does not tire.

(4) If the user/operator must make LIGHT PEN transactions more frequently than one every five minutes, place the display screen in a horizontal or nearly horizontal position so that the user/operator does not tire.

(5) Avoid using LIGHT PEN DIALOGS where the users/operators of the system will be highly sophisticated in system functions and operations.

g. Cursor Control Dialog

(1) USE CURSOR CONTROL DIALOG when conceptualizing or designing systems which have interactive graphics as their primary purpose, but which must use alphanumeric menu presentation in some processing steps.

(2) Avoid using CURSOR CONTROL DIALOG when the users/operators of the system will have no need to control the position of the cursor on the CRT screen other than to select items from an alphanumeric command menu or list.

(3) Use the same method for CURSOR CONTROL DIALOG as is used for graphics interaction.

(4) When using CURSOR CONTROL DIALOG, make the "target" for the cursor at least 10 times the size of the positioning accuracy required for interactive graphics or 1/4" square, whichever is smaller.

(5) Provide feedback to the user/operator on which "target" has been selected by CURSOR CONTROL DIALOG. Making the selected target brighter is the preferred method. (See SELECTIVE HIGHLIGHTING, p. 30.)

h. User-Initiated Command Language

(1) USE USER-INITIATED COMMAND LANGUAGE when sophisticated users are working with a system using a large number of capabilities.

b. Before committing to COMMAND LANGUAGE DIALOG, be sure to check the implications of command language code structure and syntax presented in Section 4.1.

9. Natural Language Dialog

a. USE NATURAL LANGUAGE DIALOG where UNSOPHISTICATED USER/OPERATOR must use a system with a MODERATE NUMBER OF COMMANDS.

b. USE NATURAL LANGUAGE DIALOGS when the set of commands can be made to reflect usage of COMMON ENGLISH LANGUAGE TERMS.

c. Where some SOPHISTICATED USERS will use a system with NATURAL LANGUAGE DIALOG, provide for COMMAND CODES AND ABBREVIATIONS as an option to natural language interaction.

10. Voice Input

a. USE VOICE INPUT where the user/operators HANDS AND EYES are already being used extensively IN OTHER SYSTEM OPERATIONS. For example, voice input might be useful in an interactive graphics system.

b. Limit the use of VOICE INPUT to situations where the ambient noise level is less than 90 dba.

1.2 COMMAND METHODS FOR GRAPHICS INTERACTION

I. Applications of Graphics Interaction

1. Selecting display parameters.

2. Selecting graphics commands.

3. Sketching or drawing lines on the display.

4. Following lines from hard copy.

5. Placing and moving symbols on the display.

6. Indicating symbols on the display.

7. Tracking a moving object on the display.

8. Establishing historical tracks of moving objects.

II. Methods for Graphics Interaction

1. Alphanumeric command methods.
2. Light pen/light gun.
3. Mouse.
4. Trackball.
5. Joystick.
6. Digitizing pad/tablet.
7. Cursor control keys.
8. Touch sensitive display surface.
9. Keyboard coordinate entry.
10. Scanner/digitizer.
11. Computer generated graphics.

III. Factors Influencing the Application of Methods for Graphic Interaction

1. Number of commands.
2. Line/symbol placement accuracy required.
3. Drawing speed required.
4. Line deviation tolerance.
5. Amount of clutter on the display.
6. Type of digitization required.
7. Position deviation tolerance.
8. Required speed of symbol manipulation.
9. Method of placing/moving symbol.
10. Speed of displayed target.
11. Deviation of target motion from linearity.
12. Tracking accuracy required.

IV. Criterion Areas for Graphics Interaction Methods

1. Error rates, as influenced by:

   a. Errors in placement of symbols or lines.

   b. Errors in selection of symbol.

   c. Errors in depiction of symbol.

   d. Errors in command selection resulting from requirements to carry command terms in long- or short-term memory.

   e. Mistracking of items displayed.

2. System throughput rates, as influenced by:

   a. Time required to position cursor.

   b. Time required to enter graphics commands.

   c. Time required to consult system references or HELP files for information on interactive graphics commands.

   d. Time required to select appropriate symbol on graphic display.

   e. Time required for point or stream digitization of desired feature.

   f. Time required to correct errors.

1.3 PROMPTS/HELPS

I. Areas of Application for Prompts/HELPs

1. Explanation of particular commands.

2. Explanation of classes of commands.

3. Explanation of terse error messages.

4. Information about system capabilities.

5. Information about groups of sequences of commands.

6. Information about display formats.

7. Information about extra-system procedures and activity sequences.

II. Methods of Prompts/HELPs

1. Informative prompt messages containing command format and/or syntax information.

2. HELP characters or flags tied to command strings.

3. Interleaved HELP capability.

4. References (to pointers) to external documentation.

5. Hierarchical HELP files.

6. "Stand-alone" HELP files.

III. Factors influencing applicability of prompt and HELP methods

1. Experience of the users/operators with the system.

2. Command method employed.

3. Extent to which individual commands or groups of commands are employed.

4. System response times.

5. Time required to paint the display screen or paper.

6. Amount of HELP information required.

7. Availability of main and peripheral memory.

8. Distribution of experience among users/operators.

IV. Criterion Areas for Prompts/HELPs

1. Error rates, as influenced by:

a. Lack of user/operator information about the legal commands during particular system operations.

b. Reliance on memory rather than information presented at the user/operator display.

2. System throughput rates, as influenced by:

a. Time spent in locating information which could have been presented to the user at the terminal.

b. Use of suboptimum system procedures which could have been prevented through presentation of appropriate procedures in HELP information.

c. Time required in correcting command errors.

d. Time required for trial and error specification of commands.

1.4 HYBRID COMMAND METHODS

I. Applications of Hybrid Command Methods

1. Using command methods with particular characteristics in given portions of a complex task.

2. Breaking up the monotony of specific command methods for users/operators who must spend long periods performing essentially identical tasks.

3. Providing command method options for the users/operators.

II. Hybrid Command Methods

1. Menus + Command Languages.

2. Menus + Command Languages + Fixed or Variable function keys.

3. Question and answer dialogs + Menus

4. Menus + cursor control.

5. Voice entry + graphics control methods.

6. Natural languages + command languages.

7. Fixed or variable function keys + graphics command methods.

8. FFKs or VFKs + cursor control dialogs.

9. FFKs or VFKs + cursor control dialogs + graphics interaction methods.

10. Other hybrid methods.

III. Factors Influencing Applicability of Hybrid Command Methods

All factors mentioned in the previous two sections also apply here.

IV. Criterion Areas for Hybrid Command Methods

All criterion areas mentioned in the previous two sections also apply here.

SECTION 2. DISPLAY FORMATS

Guidelines in this category specify how information should best be presented to the user/operator. Speed and ease of comprehension are important factors here. Four aspects of display formats are considered:

2.1 Fixed Format Alphanumeric Displays, where identical information is presented in the same location on all displays.

2.2 Variable Alphanumeric Displays, where the system and/or the user/operator control the absolute and relative positions of items in the display.

2.3 Graphic Displays, where the information displayed may include, but is not limited to, the characters available at an alphanumeric keyboard.

2.4 Selective Highlighting, describing techniques for differentiating displayed items of special interest to the user/operator from those which are more routine.

A provisional guideline set for the last area (2.4 Selective Highlighting) is included.

2.1 FIXED FORMAT ALPHANUMERIC DISPLAYS

I. Areas of Application for Fixed Alphanumeric Displays

1. Presentation of message formats for message data entry.

2. Presentation of message formats for message content review.

3. Presentation of fixed HELP displays.

4. Presentation of menus which are not tailored to the specific requirements of the user/operator.

5. Presentation of error messages.

6. Presentation of data retrieval information which is fixed in format and relatively fixed in content (i.e., the information may vary, but not to the extent that would preclude the use of a fixed display format).

7. Presentation of system prompts.

II. Methods of Presenting Fixed Alphanumeric Displays

1. Columnar display.

2. Row display.

3. Grouping of informational chunks.

4. Separation of data into subelements.

5. Representation of data format for displays into which data will be entered.

6. Use of selective highlighting.

III. Factors Influencing the Applicability of Methods for Presenting Fixed Alphanumeric Displays

1. Amount of information to be placed onto the display screen or page.

2. Availability of paging and/or scrolling on the display device.

3. Persistence of the phosphors on CRT display.

4. Technique used for moving the cursor from screen area to screen area for data entry formats.

5. Number of characters per unit area on the display area.

6. Character segment interference in the display.

IV. Criterion Areas for Fixed Alphanumeric Displays

1. Error rates, as influenced by:

   a. Difficulty in distinguishing among characters which interfere with each other as displayed.

   b. Difficulty in distinguishing among logical subelements of a particular data item which must be used in subsequent command or data item entry.

   c. Blurring of characters resulting from phosphor decay interference in scrolled displays.

2. System throughput rates, as influenced by:

   a. Difficulty in locating information displayed on the screen.

   b. Time spent in correcting errors.

2.2 VARIABLE ALPHANUMERIC DISPLAYS

I. Areas of Application for Variable Alphanumeric Displays

1. Presentation of lists of items which are data base retrieval "hits."

2. Presentation of summaries of items which are data base retrieval "hits."

3. Presentation of lists of messages from message queues.

4. Presentation of lists of summaries of messages from message queues.

5. Presentation of lengthy HELP displays which may be required for reference by users/operators while performing desk work.

II. Methods of Presenting Variable Alphanumeric Messages

1. Scrolling.

2. Paging.

3. User control over display format:

   a. User specification of display formats.

   b. User control over selection and storage of predefined display formats.

4. Retrieval "hit" specification review following initial search and tentative retrieval.

5. User/operator option to review summaries of information to be presented in variable alphanumeric displays.

6. Columnar display.

7. Row display.

8. Grouping of informational chunks.

9. Separation of data into subelements.

10. Use of selective highlighting.

III. Factors Influencing the Applicability of Methods for Presenting Variable Alphanumeric Displays

1. Amount of information to be placed on the display screen or display page.

2. Availability of high-speed hard copy devices at or near the user/operator terminal.

3. Requirements for comparing information in different portions of the information set to be displayed.

4. Existence of predefined information formats which will have been heavily employed by users/operators prior to or in conjunction with the use of the ADP system.

5. Possibility of predefining display formats which are optimum for particular user/operator activities.

6. Display space available.

7. Requirement to compare information in the display with other information available only through the ADP system.

IV. Criterion Areas for Variable Alphanumeric Displays

1. Error rates, as influenced by:

a. Necessity for recalling critical information from memory because the available display area will not accommodate all sets of information being compared.

b. Suboptimum display configurations/formats which make it difficult to distinguish among separate items of information which are similar in format.

c. Difficulty in distinguishing among characters which interfere with each other as displayed.

d. Difficulty in distinguishing among logical subelements of a particular data item which must be used in subsequent command or data item entry.

e. Blurring of characters resulting from overly long phosphor persistence in scrolled displays.

2. System throughput rates, as influenced by:

a. Difficulty in locating information displayed on the screen.

b. Requirement to wait for multi-line scrolling to initiate tasks.

c. Requirement to wait for printing and/or delivery of hard copy information from sites remote from the location of the user/operator.

d. Time required to correct errors.

2.3 GRAPHIC DISPLAYS

I. Areas of Application for Graphic Displays

1. Display of imagery (soft copy display).
2. Display of maps and charts.
3. Superimposition of organizational, geopolitical, and cultural features on maps and charts.
4. Depiction of quantitative relationships.
5. Depiction of networks and organizational charts.

II. Methods for Generating Graphics Displays

1. Use of chart independent data bases.
2. Use of standard mapping and charting symbology.
3. Rubber banding.
4. Overlay control.
5. Linking of display items to the data base.
6. Encoding of on-screen indications of symbol meaning and specifications.
7. Attribute encoding (including selective highlighting).
8. Graphics primitives.
9. Links to messages and text files.
10. Control over display parameters:
    a. Zoom.
    b. Pan.
    c. Scale.
    d. Projection.
    e. Other.

III. Factors Influencing the Applicability of Methods for Graphics Display Presentation

1. Resolution requirements.

2. Resolution capabilities of the available graphics hardware.

3. Speed of transmission of information from the originating computer to the user/operator display device.

4. Characteristics and capabilities of the available graphics display device(s).

5. Available graphics interaction hardware.

IV. Criterion Areas for Graphics Display Presentation

1. Error rates, as influenced by:

   a. Misinterpreting the meaning of display symbols.

   b. Accidentally selecting the wrong symbol from complex graphics displays.

   c. Failure to follow the correct line in multivariable trend displays.

   d. Failure to correctly identify depicted installations or equipments because of inadequate contrast or resolution in the soft copy display.

2. System throughput rates, as influenced by:

   a. Time required to locate desired symbols.

   b. Time required to interpret graphic presentations.

   c. Time required to correct errors of identification and interpretation.

2.4 SELECTIVE HIGHLIGHTING

I. Applications of Selective Highlighting

1. Indicate unusual values or information.

2. Indicate information which has been changed during editing or data entry.

3. Indicate information which should be changed during editing or data entry.

4. Indicate high-priority codes or messages.

5. Indicate the nature of alarms.

6. Indicate special areas of the display.

7. Indicate errors in data or command entry.

8. Provide warnings of the consequences of given commands.

9. Indicate search targets.

10. Differentiate among different levels of a multivalued variable.

II. Methods of Selective Highlighting

1. Brightness control.

2. Character size control.

3. Upper case display.

4. Reverse video or reverse display.

5. Underlining.

6. Mixing character fonts.

7. Color control.

8. Blinking, flashing, or pulsating.

9. Boxing or surrounding.

10. Arrowing.

11. Symbolic tagging.

12. Alphanumeric tagging.

13. Position displacement.

III. Factors Influencing the Applicability of Selective Highlighting Methods

1. Characteristics of the available hardware.

2. Level of ambient illumination in the operating environment.

3. Amount of information to be displayed.

4 Data transmission rates.

5. Presence of normally upper case or normally lower case information in the display.

6. Phosphor persistence.

7. Effect of aging and misalignment on the "blooming" of symbols displayed at the terminal.

8. Saturation of colors available.

9. Hardware-dependent blink or pulsate rates.

10. Availability of graphics at the user terminal.

11. Availability of special graphics symbols at the user terminal.

12. Requirement for dark adaptation for users/operators.

IV. Criterion Areas for Selective Highlighting Methods

1. Error rates, as influenced by:

   a. Failure to perceive highlighted item.

   b. Confusion among or within different methods of highlighting.

2. System throughput rates, as influenced by:

   a. Time required to recognize highlighted information.

   b. Time required to locate unhighlighted information of objectively different priority than unhighlighted information.

V. Guidelines for Selective Highlighting

1. Definition: making a portion(s) of the display look different from other portions of the display to call the attention of the user/operator to a particular type or item of information.

2. Use: highlighting makes it easier for the user/operator to find and keep track of the most important or critical information in the display.

3. Applications: selective highlighting should be used to:

   a. Indicate unusual values or information.

      EXAMPLE: A logistics sytem highlights types of equipment which are below recommended levels in a given company.

   b. Indicate information which has been changed during editing or data entry.

      EXAMPLE: A user/operator changes the number of heavy tanks in the Order-of-Battle File for an armored division of a potential aggressor.

Before the new information is stored, the system presents the user/operator with a list of some of the most important features of that portion of the Order-of-Battle File. In this list, the items which the user/operator has changed are highlighted.

c. Indicate information which <u>should be</u> changed during editing or data entry.

EXAMPLE: A file of information has been updated by reading a number of cards into the file. Some of the entries are wrong. An interactive portion of the system presents the data which have been entered into the system, with the erroneous data (as detected by the computer) highlighted.

d. Indicate high-priority messages or codes.

EXAMPLE: In an artillery data system, the user/operator must be certain that the target coordinates for a fire mission do not mean that friendly fire will impact on friendly forces. The data indicating these coordinates is therefore highlighted when it is displayed.

e. Indicate the nature of alarms.

EXAMPLE: In a communications system, the user/operator must decide how to distribute messages down the chain of command. While he/she is reviewing a set of relatively routine messages, an urgent transmission is received digitally. In a designated portion of the CRT display, the receipt of the urgent message is indicated and the source (or other information) of the message is highlighted.

f. Indicate special areas of the display.

EXAMPLE: In an EW system, the user/operator must maintain special awareness of the location of emitters which are a threat to helicopters, operating in ground support roles. In a map display, the area around the point of an Army thrust would be highlighted.

g. Indicate errors in data or command entry.

EXAMPLE: In a logistics system, the user/operator is required to enter codes for equipment types for which he/she wishes to retrieve information. The system highlights the characters in the data string which are not valid.

h. Provide warnings of the consequences of given commands.

EXAMPLES: In a system which stores and provides for update of order-of-battle information, a user/operator specifies the deletion of a particular type of data element from the entire Order-of-Battle File. The system prints out a message warning the user/operator that execution of this command will require several hours, and that the information contained in this data file will no longer be available on-line. This message is highlighted.

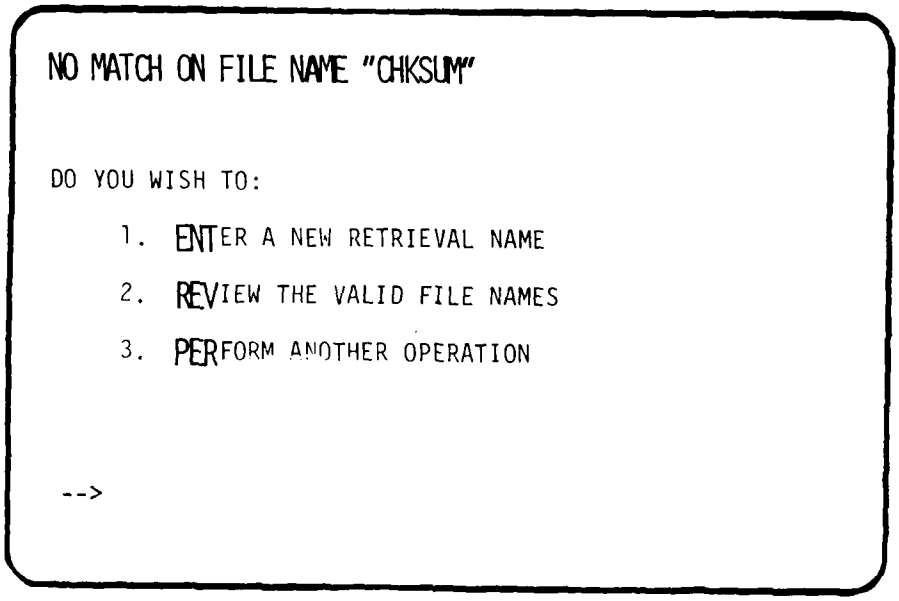
EXAMPLE: An intelligence system displays the location of potential aggressor units on a map display. For the purposes of planning for a particular operation, the user/operator is particularly concerned about the location of armored units. By entering the appropriate command, the user/operator causes the symbols indicating armored units to be highlighted on the display.

4. Types of Selective Highlighting:

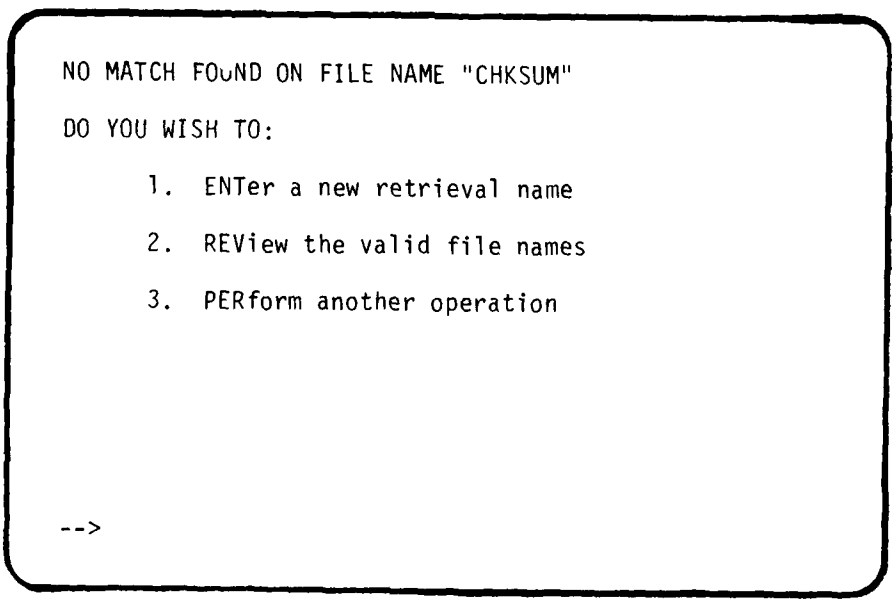
a. Brightness control: the information which is highlighted appears brighter than other information on the display.

```
NO MATCH ON FILE NAME "CHKSUM"

DO YOU WISH TO:

      1. ENTER A NEW RETRIEVAL NAME

      2. REVIEW THE VALID FILE NAMES

      3. PERFORM ANOTHER OPERATION



-->
```

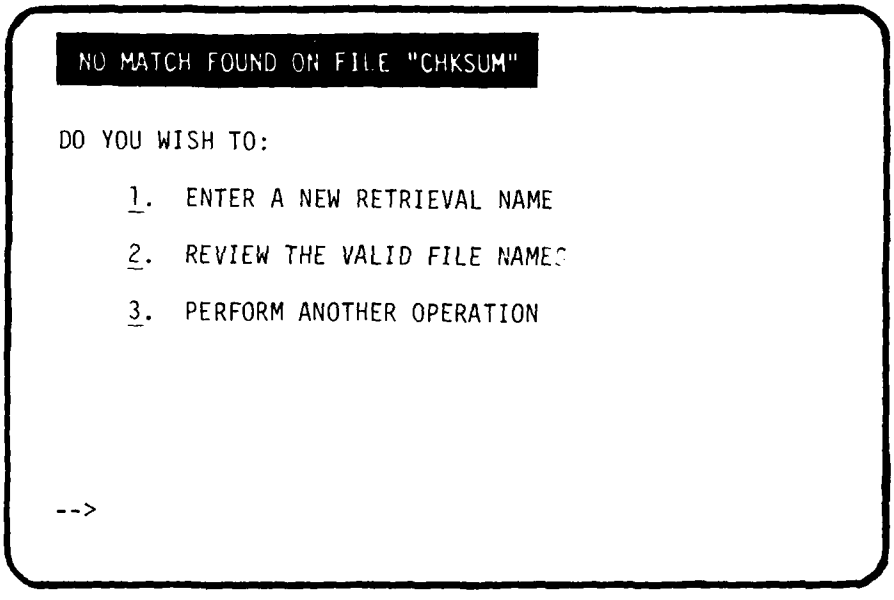
b. Character size control: the information to be highlighted is presented in larger characters than that which is not to be highlighted.



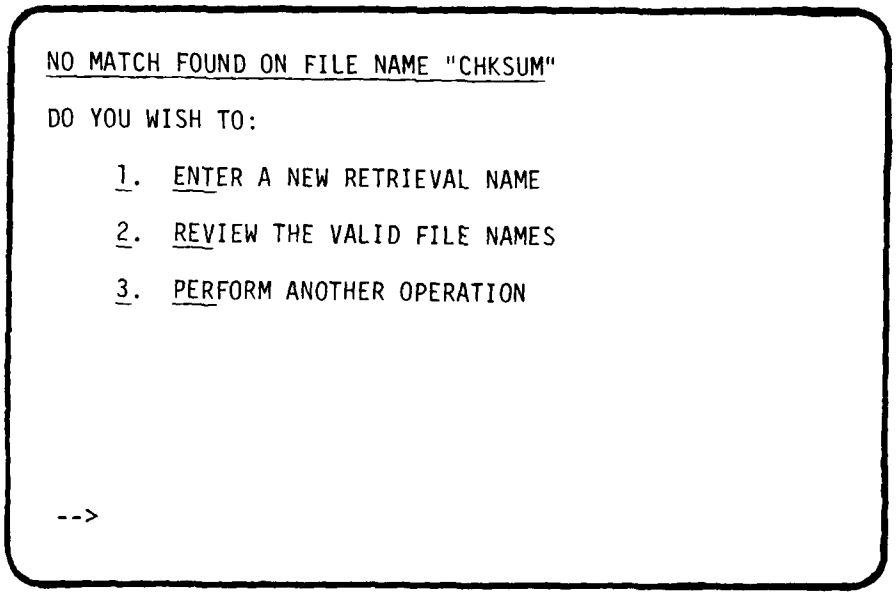
c. Upper case display: the highlighted information is presented in all capital letters.



d. Reverse display: the colors of the letters or characters and the colors of the background on which they are presented are reversed.



e. Underlining: important information on the display is underlined.



f. Mixing character fonts: the highlighted information is presented in a type style different from non-highlighted information.

NO MATCH FOUND ON FILE NAME "CHKSUM"

DO YOU WISH TO:

1. *ENT*ER A NEW RETRIEVAL NAME
2. *REV*IEW THE VALID FILE NAMES
3. *PER*FORM ANOTHER OPERATION

-->

g. Color controls: the highlighted information is presented in a color that is different from other information.

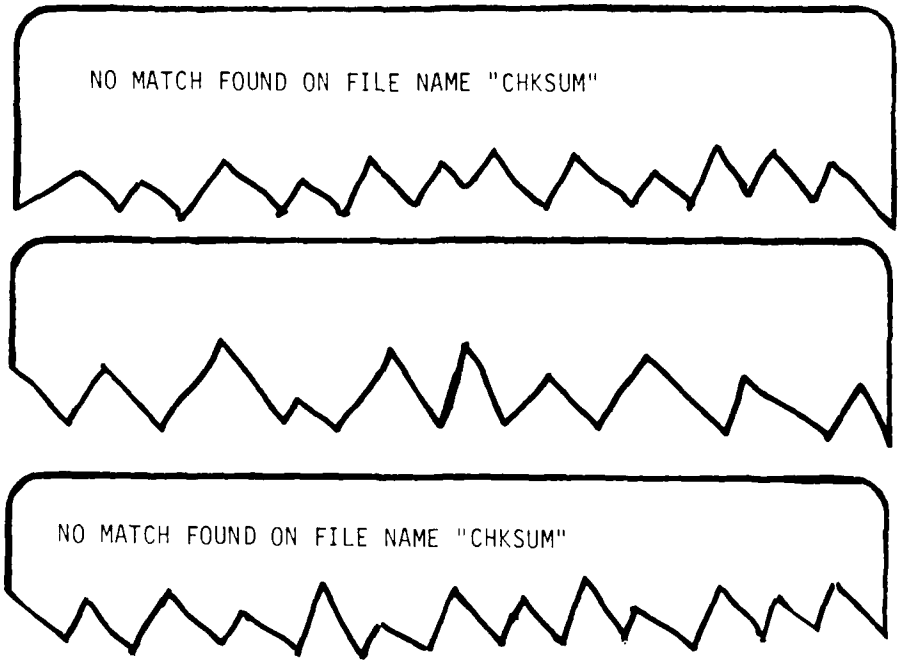
NO MATCH ON FILE NAME "CHKSUM"

DO YOU WISH TO:

1. ENTER A NEW RETRIEVAL NAME
2. REVIEW THE VALID FILE NAMES
3. PERFORM ANOTHER OPERATION

-->

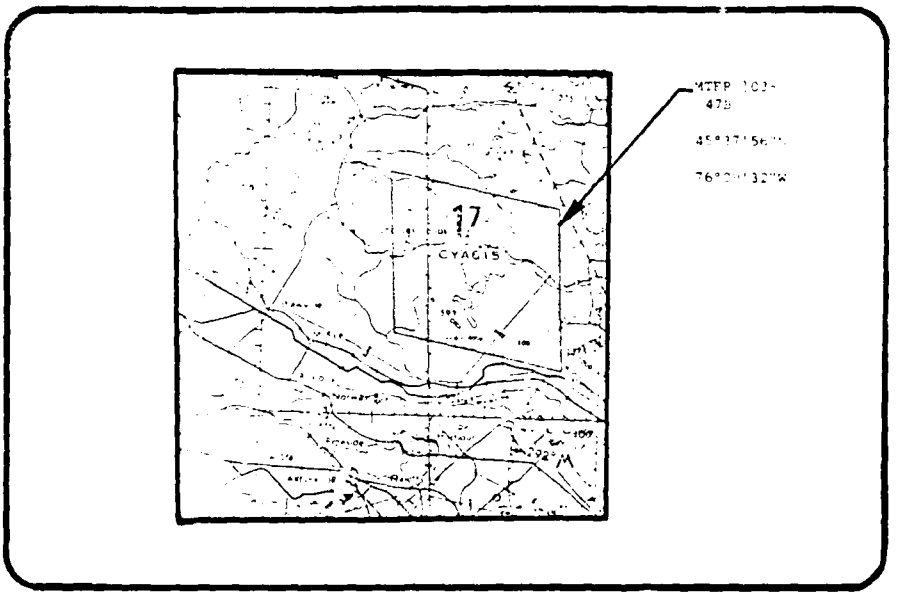
h. Blinking, flashing, or pulsating: the highlighted information blinks rapidly on and off.



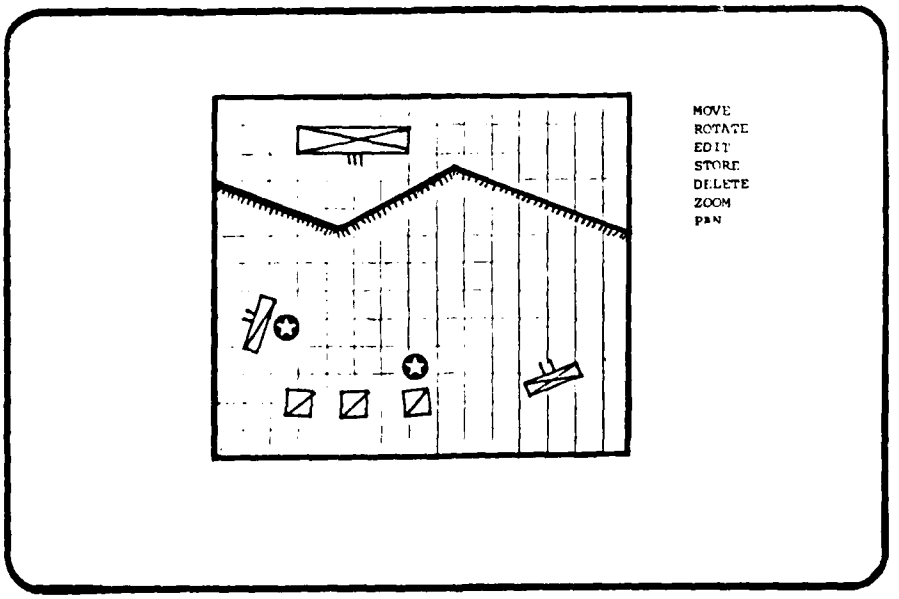
i. Boxing or surrounding: the highlighted information is contained within a box formed by lines or symbols.

```
****************************************
* NO MATCH FOUND ON FILE NAME "CHKSUM *
****************************************

***  *****
*1*  *ENT*ER A NEW RETRIEVAL NAME
***  *****

***  *****
*2*  *REV*IEW THE VALID FILE NAMES
***  *****

***  *****
*3*  *PER*FORM ANOTHER OPERATION
***  *****


-->
```

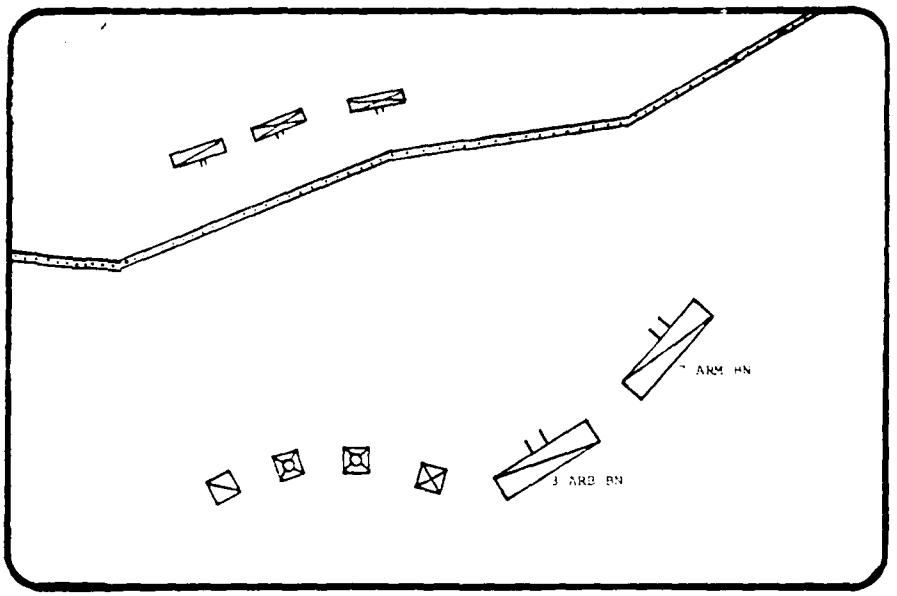
j. Arrowing: an arrow drawn on the display indicates that an item in the display is worthy of special attention.



k. Symbolic tagging: a symbol located near an item or group of items on the display indicates that it (they) are worthy of special attention.



l. Alphanumeric tagging: groups of characters located near information in the display indicate that these items are important.



m. Position displacement: information is highlighted by moving it out of its "normal" position.

THE FOLLOWING IS AN ALPHABETIZED LISTING OF THE PERSONNEL IN THE THIRD ARMORED BATTALION WITH HIGHER THAN AVERAGE RATINGS BY SUPERIORS:

AARONS, a.j., SP-4
ABRAMS, B.F., SP-5
ANDERSON, M.F., SP-4
BUTLER, F.C., E-3
CAVANAUGH, R.T., SP-5
CELLINI, B.T., E-5
COSKOWITZ, R.T., SP-5
DOTLICH, G.L., E-4
ERMANDO, S.R., SP-4
EXETER, D.D., E-5
FRANCESCA, H.J., SP-5
GALLOWAY, O.L., SP-5
.
.
.
.
.

5. Recommendations:

a. USE SELECTIVE HIGHLIGHTING to indicate information in a display which is significantly more important than other information in the display.

b. USE HIGHLIGHTING when it is desirable to GAIN THE ATTENTION of the user/operator.

c. DO NOT USE SELECTIVE HIGHLIGHTING when the amount of information to be highlighted exceeds ten percent (10%) of the total information in the display.

d. Selection of Methods. Table 3, Method of Selective Highlighting by Type or Format of Output Display, presents a general list of recommendations for the use of particular types of highlighting according to the type of output device which the user/operator will be viewing. Before making a final decision on the method of selective highlighting, be sure to consult the chart showing recommendations for highlighting method for particular applications (Table 4), as well as the detailed discussion of highlighting methods beginning on page 41.

Table 3

Method of Selective Highlighting by Type or Format of Output Display

KEY 1 = Best 2 = Second Choice 3 = Not Recommended 4 = Not Typically Available in this type of Display Highlighting Method	Type or Medium of Display			
	Alphanumeric CRT Terminal	Graphic CRT Terminal	Alphanumeric Hard Copy Terminal or Printer	Plotter, Printer/ Plotter
Brightness Control	1	1	4	4
Character Size Control	1	1	1	1
All Upper Case	2	2	2	2
Reverse Display	1	1	4	4
Underlining	2	2	2	2
Different Font	2	2	1	2
Color Control	4	1	4	1
Blinking, Pulsating	3	3	4	4
Boxing	2	1	2	1
Arrowing	4	2	4	2
Symbolic Tagging	4	2	4	2
Alphanumeric Tagging	3	3	3	3
Position Displacement	3	3	3	3

Table 4

Method of Selective Highlighting by Reason for Using Highlighting

KEY: 1 = Best 2 = Second Choice 3 = Not Recommended	Highlighting Application								
Highlighting Method	Unusual Values	Information Changed	Information to be Changed	High-Priority Messages/Codes	Alarms	Special Areas of Display	Command/Data Entry Errors	Warnings of Consequences	Indicate Search Targets
Brightness Control	1	1	1	1	2	1	1	1	1
Character Size Control	1	1	1	1	3	3	1	1	2
All Upper Case	2	2	2	2	3	3	2	2	3
Reverse Display	2	2	2	2	2	3	2	3	1
Underlining	2	2	2	2	3	3	2	2	3
Different Font	2	2	2	2	3	3	2	3	3
Color Control	1	1	1	1	2	1	1	1	1
Blinking, Pulsating	3	3	3	2	1	3	3	3	2
Boxing	3	3	3	1	3	1	2	1	2
Arrowing	2	2	2	3	3	3	2	3	2
Symbolic Tagging	2	2	2	3	3	3	3	3	2
Alphanumeric Tagging	3	3	3	3	3	3	3	3	3
Position Displacement	2	2	3	3	3	3	2	3	2

6. Advisory Comments:

a. Brightness Control

(1) DO NOT USE BRIGHTNESS CONTROL when MORE THAN THREE LEVELS of brightness are employed.

(2) DO NOT USE BRIGHTNESS CONTROL when the lighting in the area where transactions must be performed is TOO BRIGHT TO PERMIT ADEQUATE DISCRIMINATION OF BRIGHTNESS LEVELS in the display.

(3) DO NOT USE BRIGHTNESS CONTROL when the amount of illumination coming from the display will INCREASE PROBABILITY OF DETECTION OF THE USER/OPERATOR by potential aggressor forces.

(4) DO NOT USE BRIGHTNESS CONTROL when its use will cause the user/operator to perform poorly on his/her other tasks because the excess light from the display makes his/her eyes ADAPT TO THE BRIGHTNESS OF THE DISPLAY.

b. Character Size Control

(1) DO NOT USE CHARACTER SIZE CONTROL when it REDUCES THE NUMBER OF CHARACTERS WHICH CAN BE PLACED ON THE DISPLAY and INCREASES THE NUMBER OF PAGES in a multi-page display.

(2) DO NOT USE CHARACTER SIZE CONTROL where the TYPE OF CHARACTER used in highlighting DECREASES THE LEGIBILITY of the display.

(3) DO NOT USE CHARACTER SIZE CONTROL where the "BLOOMING" OR "BLURRING" of the larger characters DECREASES THE LEGIBILITY of other information in the display.

c. All Uppercase

(1) DO NOT USE ALL UPPERCASE where the legibility of the highlighted information is important. (Use of all capital letters makes text difficult to read.)

(2) DO NOT USE ALL UPPERCASE for highlighting where other information on the display would NORMALLY BE PRESENTED IN UPPERCASE, (e.g., where the display contains military acronyms such as CINCPAC, CINCEUR, USAFE, etc.)

(3) DO NOT USE ALL UPPERCASE where it would interfere with a code scheme in which LOWERCASE CHARACTERS ARE REQUIRED.

d. Reverse Display

(1) DO NOT USE REVERSE DISPLAY when its use will cause the user/operator to perform his/her other tasks poorly because excess light from the display makes his/her eyes ADAPT TO THE BRIGHTNESS OF THE DISPLAY.

(2) DO NOT USE REVERSE DISPLAY when its use increases the amount of light coming from the display, INCREASING THE PROBABILITY OF DETECTION of the user/operator by an enemy.

(3) DO NOT USE REVERSE DISPLAY when the "BLOOMING" or "BLURRING" caused by the bright background DECREASES THE LEGIBILITY of the display.

e. Underlining

(1) USE UNDERLINING when maintaining the legibility of highlighted text is crucial.

(2) DO NOT USE UNDERLINING when highlighted characters and underline appear on two different display lines.

(3) DO NOT USE UNDERLINING when its use will require that the number of pages in the display be increased.

(4) DO NOT USE UNDERLINING when the underlining CANNOT BE OVERLAID on the information to be highlighted.

(5) DO NOT USE UNDERLINING when "BLOOMING" or "BLURRING" caused by the underlining REDUCES THE LEGIBILITY of highlighted or other characters.

(6) DO NOT USE UNDERLINING for highlighting when this technique is already being USED FOR OTHER PURPOSES.

(7) DO NOT USE UNDERLINING for ALARMS or when it is crucial to gain the attention of the user/operator by means of selective highlighting.

f. Different Character Fonts

(1) DO NOT USE DIFFERENT FONTS when the font which must be used for highlighting REDUCES THE LEGIBILITY of highlighted information.

(2) DO NOT USE DIFFERENT FONTS when the difference between the two fonts is NOT SUFFICIENT TO PRODUCE THE DISTINCTIVENESS required for highlighting.

(3) DO NOT USE DIFFERENT FONTS when the AMOUNT OF INFORMATION NEEDED TO CONSTRUCT CHARACTERS IN THAT FONT INCREASES TRANSMISSION TIME.

(4) DO NOT USE DIFFERENT FONTS for ALARMS or when it is otherwise necessary to gain the attention of the user/operator by means of selective highlighting.

g. Color Coding

(1) USE COLOR CODING when the number of categories of highlighting is large (see "ATTRIBUTE CODING").

(2) DO NOT USE COLOR CODING when the available colors are of such density and hue that they are likely to be confused by personnel with DEFECTIVE COLOR VISION.

(3) DO NOT USE COLOR CODING if the use of color REDUCES THE LEGIBILITY of highlighted or other characters.

(4) DO NOT USE COLOR CODING if lighting in the areas where users/operators interact with the system will cause the COLORS TO WASH OUT.

(5) USE RED COLOR CODING if it is desirable to avoid having users/operators adapt to the brightness of the display.

(6) USE THE MOST EASILY READABLE COLOR (usually yellow-green or white) for NORMAL OR UNHIGHLIGHTED INFORMATION.

(7) USE RED COLOR CODING for ALARMS OR other situations where it is necessary to gain the attention of the user/operator through the use of selective highlighting.

(8) USE GREEN COLOR CODING to indicate NORMAL OR NON-ALERT status.

h. Blinking, Pulsating, or Flashing

(1) USE BLINKING ONLY for ALARMS or in other situations where alerting or gaining the attention of the user/operator outweights the irritation and reduced legibility caused by blinking, flashing, or pulsating information.

(2) DO NOT USE BLINKING where this form of highlighting CANNOT BE TURNED OFF by the user/operator.

(3) USE BLINKING ONLY when the highlighted information flashes "on" three (3) to five (5) times per second.

(4) DO NOT USE BLINKING when the terminal to be used has LONG-PERSISTENCE PHOSPHORUS which would cause the rate of blinking to be less than three to five times per second.

i. Boxing

(1) USE BOXING when there is a need to highlight LARGE AMOUNTS OF TEXT.

(2) DO NOT USE BOXING when the information to be highlighted is SCATTERED MORE OR LESS RANDOMLY throughout the display.

(3) DO NOT USE BOXING when this form of highlighting would require INCREASING THE NUMBER OF PAGES of a display.

(4) USE BOXING to INDICATE "WORKING" PORTIONS of a display.

j. Arrowing

(1) USE ARROWING when there is a need to LOGICALLY CONNECT TWO SYMBOLS OR GROUPS OF SYMBOLS such as connecting the code name of an organization to a chart symbol referring to that organization.

(2) DO NOT USE ARROWING where MANY ITEMS must be highlighted simultaneously.

(3) DO NOT USE ARROWING to indicate items to be SCANNED.

(4) DO NOT USE ARROWING to indicate ALARMS or other high-priority messages and codes.

k. Symbolic Tagging

(1) DO NOT USE SYMBOLIC TAGGING IF OTHER METHODS OF HIGHLIGHTING ARE AVAILABLE.

l. Alphanumeric Tagging

(1) USE ALPHANUMERIC TAGGING where there is a need to provide a CODE LINK between a symbol on the display and more detailed information about the thing that the symbol represents, e.g., use the tag "3ARM_BN" to retrieve more information about a symbol on a map display which represents the position of the third armored battalion.

(2) DO NOT USE ALPHANUMERIC TAGGING where there is a pressing need for distinctiveness in highlighting.

(3) DO NOT USE ALPHANUMERIC TAGGING to highlight alphanumeric information, unless the tagging is accompanied by the application of other sorts of selective highlighting, e.g., brightness control, position displacement.

m. Position Displacement

(1) USE POSITION DISPLACEMENT where vertically-oriented lists of information must be RAPIDLY SCANNED.

(2) USE POSITION DISPLACEMENT where displays which are to be scanned MUST BE SCROLLED.

SECTION 3. DATA ENTRY ASSISTANCE

Guidelines in this category suggest ways for maximizing the speed and accuracy of user/operator entry of information into the ADP system. Three aspects of data entry assistance are considered:

3.1 Information on Legal Entries, dealing with methods for presenting the user/operator with information on the content and format of data to be entered into the ADP system.

3.2 Unburdening of Input, or techniques reducing the number of keystrokes required for entering data into the ADP system. Methods for minimizing the extent of redundant data entry are also considered.

3.3 Interrupts and Work Recovery, discussing methods for minimizing the disruption caused by requirements to perform high-priority tasks or system component failure.

3.1 INFORMATION ON LEGAL ENTRIES

I. Applications for Provision of Information on Legal Entries

1. The format of the information to be entered is critical to the interpretation of the entry by the ADP system.

2. The codes for a data field are limited in number and rigidly constrained in content.

3. The user's/operator's entry can be valid but still incorrect.

4. The user/operator may have difficulty recalling valid codes, because of inexperience or because the set of codes is large.

5. The codes or terminology used in the ADP system differ from corresponding standard codes used in most other situations,

6. The range of values for a numerical data field is limited.

7. Each of the possible codes is lengthy.

II. Methods for Providing Information on Legal Entries

1. Input menus.

2. Hierarchical input menus.

3. Input examples.

4. Display linkages to system references or legal entry code books.

5. User-definable data entry codes.

6. HELP files.

7. Hierarchical HELP files.

8. Interlaced HELP files.

9. Lined HELP files.

10. Highlighting of error messages.

11. Error-contingent legal entries lists.

12. Dual mode data entry procedures.

13. Computer generation of candidate entries.

III. Factors Influencing the Applicability of Methods for Providing Legal Entries Information

1. Data transmission rates.

2. Availability of consistent legal entries sets.

3. Sophistication of the operators.

4. Number of possible legal entries.

5. Rate of use of each of the legal entries for particular classes of information.

6. Length of legal codes.

7. Extent to which the legal entries can be calculated or derived or retrieved by the computer system.

IV. Criterion Areas for Information on Legal Entries

1. Error rates, as influenced by:

   a. Failure to recall legal entries.

   b. Typographical errors made in entering long data entry strings.

   c. Errors resulting from failure to remember data entry codes after consulting HELP files or system reference manuals.

2. System throughput rates, as influenced by:

   a. Time to locate legal values information.

   b. Time to display long lists of legal entries at the user terminal.

   c. Time to locate reference documents.

   d. Time to look through HELP displays.

   e. Time to correct errors.

V. Guidelines for Legal Entries Information

1. Definition: information on legal entries describes the characteristics of data items that are fixed in format or length, or which are restricted to sets of specified characters, words, or codes.

2. Use: information on legal entries is used to assist the user/operator to enter valid and correct information into the ADP terminal.

3. Applications: information on legal entries should be provided when:

   a. The format of the data to be entered is critical to correct interpretation of the entry by the ADP system.

      EXAMPLE: In a particular tactical ADP system, the user/operator must enter the date according to the format YYDDMM; any other format, such as DDMMYY, will be incorrect. Information on legal entries permits the user/operator to determine the proper format.

   b. The codes for a data field are limited in number and rigidly constrained in content.

      EXAMPLE: In an order-of-battle data exploitation system, the ADP software can recognize only certain codes specified for particular equipments. Thus,

a user/operator who wants to refer to the Soviet T-72 heavy tank must enter "VTNK(T72)." Entering "SOVIET T72," "T-72 TANK," "SOVIET HEAVY TANK," "T72," or any other variant will be rejected by the system as an illegal entry. Information on legal entries provides guidance to the user/operator in determining the correct code for the data element he/she wants to represent.

c. The user's/operator's entry can be valid but still incorrect.

EXAMPLE: In a field artillery ADP system, the user may have the option to select from a variety of types of rounds (high explosive, armor piercing, fragmentation, smoke, etc.). Thus, any one of several entries would be valid in response to the system's data entry prompt (e.g., "ENTER TYPE OF ROUND -->"), even though only one might be appropriate for a particular situation. If the user/operator wants to call for high explosive rounds, but enters "SM" (for smoke) instead of "HE," the system has no way to "know" that the entry is an error. Information on legal entries permits the user/operator to review the available options for the data entry field, and to select the code that matches his or her intentions.

d. The user/operator may have difficulty recalling valid codes because of inexperience or because the set of codes is large.

EXAMPLE: In a communications system, experienced users/operators have learned the codes to be entered into each of ten message formats. The system must, however, be able to operate even if all experienced users/operators have become disabled or otherwise unavailable. Information on legal entries will permit inexperienced personnel to continue system operations, even if with reduced efficiency.

EXAMPLE: In an administration system, the user/operator must enter a code to denote a particular type of medical supply. The set of such codes is large, numbering into the thousands. Even highly experienced users/operators cannot remember all the codes and the medical item that each code represents. Information on legal entries assists the user/operator in selecting the code appropriate to a particular data item.

e. The codes or terminology used in the ADP system differ from corresponding standard codes used in most other situations.

EXAMPLE: In a command and control system, the phrase "Free Fire Area" is coded as "FCA," rather than the doctrinal "FFA" as specified in FM6-20. Information on legal entries alerts the user/operator to the existence of such non-standard usages.

f. The range of numerical values for a data field is limited.

EXAMPLE: In an intelligence information system, the user/operator must enter latitudes in degrees. Entering the value "97" exceeds the legal limit for a latitude. Information on legal entries shows the user/operator the range of legal values.

g. Each of the possible codes is lengthy.

EXAMPLE: In a command and control system, the user/operator must enter a unit ID for companies which includes all of the unit's parent organizations up to division (for example, C Company, 1st of the 64th Armor, 2nd Brigade, 14th Armored Division must be entered as 14-2-1-64-C). Information on legal entries helps the user/operator to enter the required data.

4. Types of Information on Legal Entries:

a. Input menus. Two types of input menus can be used to show the user/operator the legal entries for a data field, simple and hierarchical:

(1) Simple input menus are used when the number of legal entries is small enough to require no more than two columns on the display screen.

```
AVAILABLE AMMUNITION TYPES ARE:

    1.  ARM --- ARMOR PIERCING
    2.  BIO --- BIOLOGICAL
    3.  ILL --- ILLUMINATION (FLARE)
    4.  FRA --- FRAGMENTATION
    5.  GAS --- GAS/CHEMICAL
    6.  INC --- INCENDIARY
    7.  NUC --- NUCLEAR
    8.  SMO --- SMOKE

ENTER THE # OR LETTER CODE FOR DESIRED AMMUNITION TYPE, OR
ENTER ONLY A CARRIAGE RETURN TO GET BACK -->
```

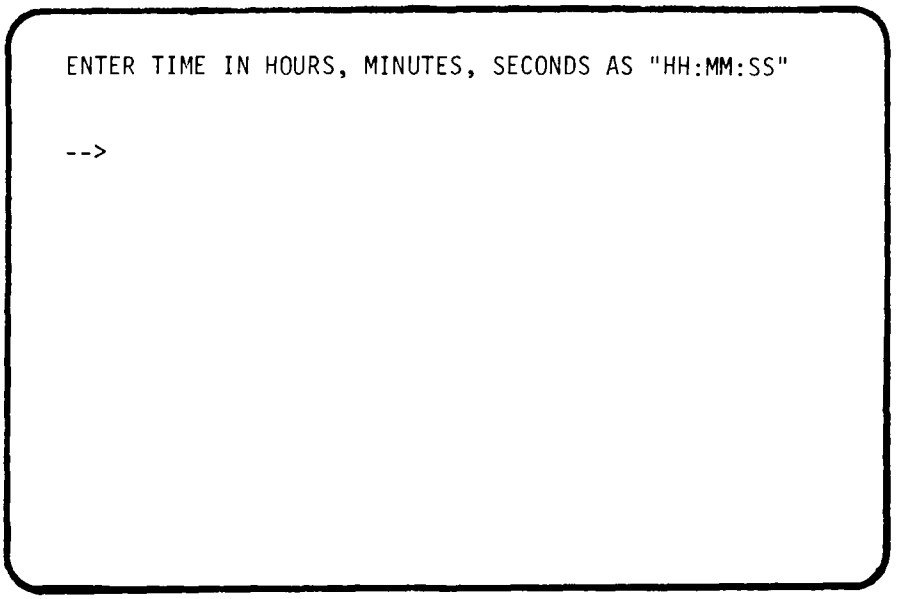
(2) Hierarchical input menus are used when the number of legal entries exceeds two columns on the display screen.

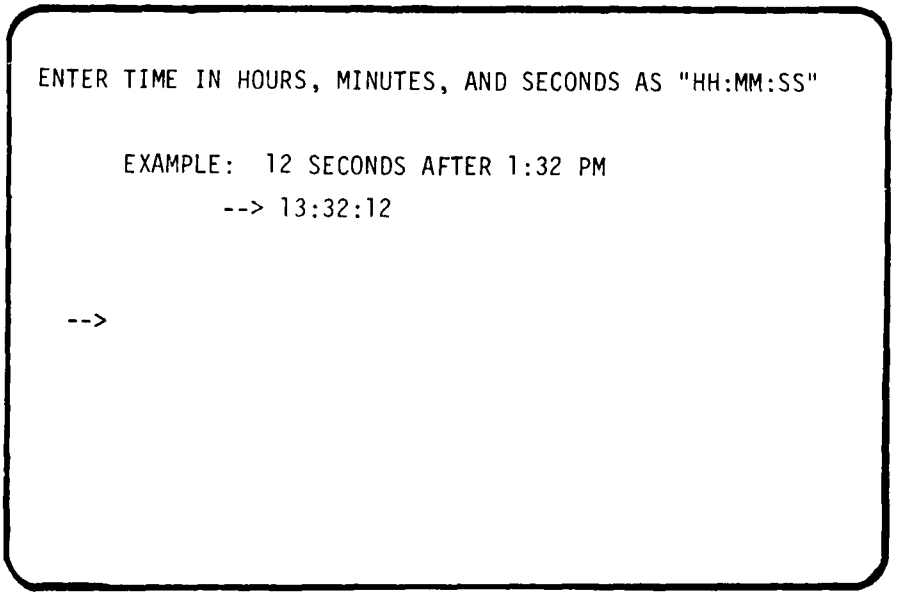
```
IN WHAT TYPE OF EQUIPMENT ARE YOU INTERESTED?

    1.  CO --- COMBAT EQUIPMENT
    2.  AI --- AIR EQUIPMENT
    3.  TR --- TRANSPORTATION EQUIPMENT
    4.  EN --- ENGINEERING EQUIPMENT
    5.  etc.




--> CO
```

```
  IN WHAT TYPE OF COMBAT EQUIPMENT ARE YOU INTERESTED?

      1.  ARM --- ARMORED EQUIPMENT
      2.  CMD --- COMMAND AND CONTROL EQUIPMENT
      3.  INF --- INFANTRY EQUIPMENT
      4.  etc.




--> ARM
```

Depending on the user's/operator's purposes, an additional frame could list specific pieces of armored equipment, or the user/operator might request a summary of available armored equipment or request some other processing function.

b. Input examples. Input examples are used to show the user/operator the correct format of legal entries, the correct content of legal entries, or both.





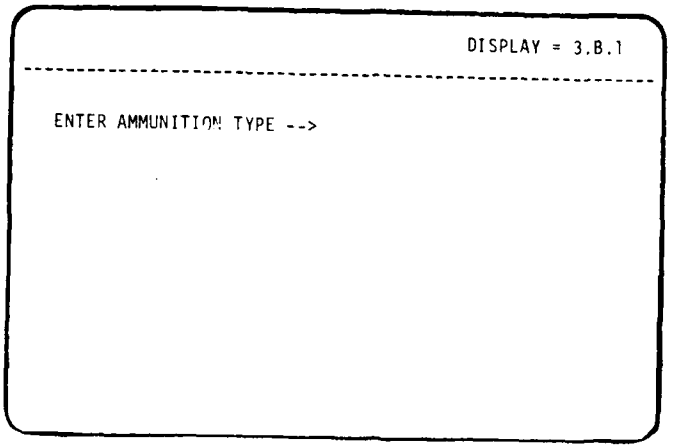
c. User-definable data entry codes. User-definable data entry codes permit the user/operator to define "shorthand" codes which represent lengthier data entry codes.

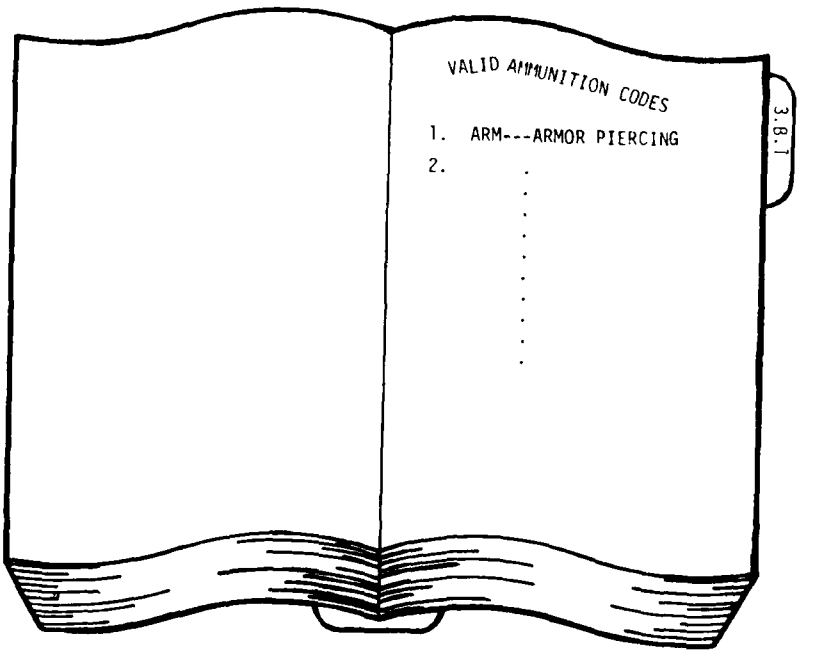
CODE	STANDS_FOR
3H	303_FA_BD_HQ
4S	404_FA_BD_SD

ENTER UNIT DESIGNATION --> 303_FA_BD_HQ (VALID ENTRY CODE)

ENTER UNIT DESIGNATION --> 3H (VALID ENTRY CODE)

d. Display linkages. Display linkages direct the user from a particular data entry display to a section of a legal data entry code book or manual containing information on legal entries.





e. Code Books and manuals. Code books and manuals provide detailed information on legal entries which cannot be placed on data entry displays.

5. Recommendations:

a. USE the user/operator TERMINAL to PROVIDE INFORMATION ON LEGAL ENTRIES whenever possible.

b. USE the HIGHEST computer-to-terminal DATA TRANSMISSION RATES possible for displaying information on legal entries to the user/operator terminal. Minimum data transmission recommendations are presented in Figure ?.

c. PROVIDE A MEANS for the user/operator to PREVENT THE SYSTEM FROM DISPLAYING LEGAL DATA ENTRY INFORMATION if he/she is experienced enough not to need it. (NOTE: this is particularly important if data transmission rates to the user/operator terminal are low.)

d. PROVIDE ILLUSTRATIONS AND EXAMPLES for legal data entry information whenever possible.

e. PROVIDE DEFINITIONS FOR ALL DATA ENTRY CODES.

f. ORDER the information on legal entries in a manner which is CONSISTENT with the way in which the USER/OPERATOR will USE THE INFORMATION. Some examples of ordering methods are:

(1) ALPHABETICAL ORDERING, in which codes are arranged alphabetically (e.g., codes for designating countries).

(2) SUBJECT ORDERING, in which codes are arranged by the subject with which they deal (e.g., codes for types of combat equipment).

g. PROVIDE DUPLICATE CODE ORGANIZATION METHODS where DIFFERENT USER/OPERATORS may desire to locate codes in DIFFERENT WAYS.

h. PROVIDE DUPLICATE LEGAL ENTRY INFORMATION where users may use different terms to mean the same thing, for example:

Type of Legal Data Entry Information	Approximate Number of Characters	DESIRED DISPLAY TIME		
		FAST (1 Second to Put Data on Screen)	MODERATE (5 Seconds to put Information on Screen)	SLOWEST ACCEPTABLE (15 Seconds to put Information on Screen)
Format for a Data Entry Code	1Ø	1Ø characters per second (about 1ØØ baud)	2 characters per second (about 2Ø baud)	Ø.7 characters per second (about 7 baud)
Format and Example for Data Entry Code	5Ø	5Ø characters per second (about 5ØØ baud)	1Ø characters per second (about 1ØØ baud)	3 characters per second (about 3Ø baud)
Short Data Entry Menu (About 4-8 Options in Menu)	2ØØ	2ØØ characters per second (about 24ØØ baud)	4Ø characters per second (about 4ØØ baud)	13 characters per second (about 13Ø baud)
Long Data Entry Menu; Single Page of Multi-Page Data Element Dictionary or Help File	1ØØØ	1ØØØ characters per second (about 1Ø,ØØØ baud)	2ØØ characters per second (about 2ØØØ baud)	67 characters per second (about 67Ø baud)

Figure 2. Minimum Data Transmission Rates for Various Types of Legal Data Entry Information and Desired Display Times.

COUNTRY NAME	CODE
RUSSIA	URS
⋮	⋮
SOVIET UNTION	URS
⋮	⋮
UNION OF SOVIET SOCIALIST REPUBLIC	URS
⋮	⋮

i. ALWAYS provide LEGAL ENTRIES IN CODEBOOKS OR MANUALS (even when legal entry information is available at user terminals), for off-line study and reference.

Table 5 shows general recommendations for the use of different methods for presenting information on legal entries according to the particular application being considered. The user of these recommendations should consult the advisory comments later in this section before deciding which method(s) to use.

Table 5

Method of Presenting Information on Legal Entries by Application Being Considered

KEY:
1 = Best
2 = Second Choice
3 = Not Recommended
4 = Not Applicable

PRESENTATION METHOD \ APPLICATION	CRITICAL FORMAT	CRITICAL CONTENT	VALID BUT INCORRECT	RECALL DIFFICULTIES	NON-STANDARD TERMINOLOGY	LENGTHY CODES
INPUT MENUS						
• SIMPLE	4	1	1*	1*	1	3
• HIERARCHICAL	4	1	1	1	1	3
INPUT EXAMPLES						
• FORMAT	1*	4	4	2	2	3
• CONTENT	4	1*	4	2	2	1
USER DEFINED CODES	4	2	2	2	1*	1*
DISPLAY LINKAGES	4	2	2	2	2	2
CODE BOOKS & MANUALS	2	2	2	2	2	2

*Recommended as 1st choice for standardization purposes

6. Advisory Comments:

a. Input menus

(1) USE information on legal entries on input menus where the user/operators of the system are likely to be INEXPERIENCED in the content of legal entries.

(2) USE information on legal entries on input menus where INPUT CODES ARE LONG, only if the user/operator can benefit from POSITIONAL CODING in the menu.

(3) PROVIDE a method for EXPERIENCED USER/OPERATORS to STACK COMMANDS to bypass input menus.

(4) DO NOT USE menus of legal entries where DATA TRANSMISSION RATES are LOW (below 1200 baud).

b. Input examples

When possible, use FORMAT and CONTENT examples in COMBINATION, rather than using one or the other (a CONTENT example illustrates the format; a FORMAT example makes the format more explicit).

c. User-definable data entry codes

(1) USE user-definable data entry codes where DIFFERENT USERS are likely to USE DIFFERENT SETS OF data entry codes.

(2) USE user-definable data entry codes where users/operators will use some codes more frequently than others.

d. Display linkages

USE display linkages where LOW COMPUTER STORAGE CAPACITY limits the amount of information which can be placed on data entry display menus and/or in help files.

e. Code books and manuals

(1) ALWAYS PROVIDE LEGAL ENTRIES IN CODEBOOKS (even when legal entry information is available at the user terminal), for off-line reference and study.

(2) ORDER the information on legal entries in a manner which is CONSISTENT with the way in which the USER/OPERATOR will USE THE INFORMATION. Some examples of ordering methods are:

(a) ALPHABETICAL ORDERING, in which codes are arranged alphabetically (e.g., codes for designating countries).

(b) SUBJECT ORDERING, in which codes are arranged by the subject with which they deal (e.g., codes for types of combat equipment).

(c) DISPLAY ORDERING, in which codes are arranged so that valid codes for a particular display are all in a single place in the codebook or manual.

(3) PROVIDE DUPLICATE CODE ORGANIZATION METHODS where DIFFERENT USER/OPERATORS may desire to locate codes in DIFFERENT WAYS.

(4) PROVIDE DUPLICATE LEGAL ENTRY INFORMATION where users may use different terms to mean the same thing. For example:

COUNTRY NAME	CODE
RUSSIA	URS
SOVIET UNION	URS
UNION OF SOVIET SOCIALIST REPULBICS	URS

3.2 UNBURDENING OF INPUT

I. Areas of Application for Unburdening of Input

1. Command entry.
2. Data entry.
3. Error remediation.
4. Output format specification.
5. Verification.
6. Access to external systems and capabilities.

II. Methods of Unburdening of Input

1. Use of menus.
2. Use of tailored menus.

3. User/operator specification of shorthand for frequently used commands or command strings.

4. Command files.

5. Format files.

6. Computer calculation of values and command strings.

7. Computer generation of values and command strings.

8. Propagation of values which do not often change and can be specified at the time of system or shift initialization.

9. Use of checklists.

10. Calculation of graphic and geographic coordinates from graphics displays.

11. Calculation of other values from graphic displays.

12. Identification of items from graphic displays by determination of item position relative to the graphic cursor.

13. Use of mnemonic codes.

14. Display of command prompts and menu items contingent on previous responses and commands.

15. Computer generation of "most likely" command and data entry strings on the basis of previous user/operator interaction with the system.

16. Linked HELP messages.

17. Sophisticated computer parsing of command strings.

18. User/operator control of verification process.

III. Factors Influencing the Applicability of Methods for Unburdening of Input

1. Requirement for verification of responses.

2. Existence of standard codes and mnemonics which have been or are being used by user/operators in contexts other than system interaction.

3. Speed of transmission of information from the originating computer to the user/operator display.

4. Speed of terminal display.

5. Relative experience of system users/operators.

6. Availability of local terminal intelligence.

7. Availability of main and peripheral memory in the system.

8. Existence of data input forms to be used by the users/operators in entering data into the system.

9. Criticality of errors in given system processes.

10. Constraints on the format of commands or data entries.

11. Amount of information to be included as legal options in command sets or data entry sets.

12. Requirements for free text data entry.

13. Typical extent of use of command sets and data entry sets by users/operators.

IV. Criterion Areas for Unburdening of Input

1. Error rates, as influenced by:

a. Inability of the user/operator to maintain throughput requirements given the amount of command or data entry keystrokes necessary.

b. Probability of typographical error for each keystroke.

c. Judgmental or logical errors in defining complex sequences in commands which could have been "canned" by the users/operators in previous executions of the same command sequence.

d. Probability of selecting commands or data entry options which are invalid given prior user/operator command or data entries.

e. Transcription errors in data or command input which could have been generated or obtained by the computer system.

f. Increased error rate associated with entry of redundant information for purposes other than verification and validation.

g. Misestimations from graphic displays.

h. Failure to accurately recall command or data entry content/format presented on non-linked help displays.

2. System throughput rates, as influenced by:

   a. Time required for entry of individual commands which require more keystrokes than necessary.

   b. Time required to generate commands which could have been stored for subsequent use.

   c. Time required to enter redundant commands in situations other than verification and validation processes.

   d. Time required to correct errors resulting from inadequate attention to considerations of unburdening of input.

3.3 INTERRUPTS AND WORK RECOVERY

I. Areas of Application for Methods for Dealing with Interrupts and Work Recovery

   1. Reacting to high-priority messages and tasks.

   2. Simultaneous work in background and foreground modes.

   3. Recovery from total system failure.

   4. Recovery from failure of system component.

   5. Startup following system movement.

   6. Restart following system reconfiguration, or reconfiguration of elements in a system network.

II. Methods for Dealing with Interrupts and Work Recovery

   1. Checkpointing at the individual user/operator level.

   2. Local or off-line retention of command strings or results of command entry.

   3. Local or off-line retention of data base updates.

   4. Provisions for saving partially completed data entry sets.

   5. Provisions for saving in-process ADP procedures.

   6. Automatic generation and local backup storage of command sequences.

   7. Storage and recovery of processing contexts.

8. Nondestructive notification of high-priority events.

9. Use of multiple-screen displays.

10. Provisions for interfacing a variety of terminals.

11. File naming conventions for semi-automated storage of interrupted and partially completed work.

12. Automated hard copy production of interrupt- or system failure-sensitive data and command entry items.

13. Provision of local degraded mode operations.

14. Standard startup configurations with user/operator options to modify them.

III. Factors Influencing the Applicability of Methods for Dealing with Interrupts and Assuring Work Recoverability

1. Availability of local terminal intelligence.

2. Availability of local mass storage devices.

3. Availability of local hard copy capability.

4. Speed of local hard copy capability.

5. Priority scaling.

6. Relative permanence of system and network configurations.

7. Characteristics of terminal hardware.

IV. Criterion Areas for Dealing with Interrupts and Assuring Work Recoverability

1. Error rates, as influenced by:

a. Probability of error increased by requirement for entering redundant information.

b. Increased probability of error associated with entry of commands and data which are only rarely used.

c. Attempts to complete a partially finished task without provision of the appropriate task-contextual cues.

d. Inconsistency between methods for completing a partially completed task and those used for performing a task from start to finish.

2. System throughput rates, as influenced by:

   a. Requirements for redoing work lost during system failure.

   b. Requirements for redoing work interrupted by higher-priority tasks.

   c. Requirements for the system to reprocess information when an active task was interrupted because of system failure or the presence of higher-priority tasks.

   d. Necessity for reevaluating the context in which an interrupted task was being performed.

   e. Lack of an ability to perform any operations during conditions of partial system failure.

   f. Lack of available reference materials to reestablish full operational status following restart.

   g. Excess time required to restart system after relocating it or its elements.

   h. Time required to specify detailed system restart instructions.

   i. Time required to reenter data which was lost due to interruption or system failure.

3. User/operator frustration and irritation, as influenced by:

   a. Requirements for entry of redundant information.

   b. Destruction of partially completed tasks on receipt of high-priority information.

4. Data base integrity compromise, influenced by:

   a. Loss of information being processed or entered at the time of system failure or interruption of user/operator activities by higher priority tasks.

5. Compromise of system or network configuration integrity, as influenced by:

   a. Requirement to perform detailed system- and/or network-configurational command entry at each system restart.

SECTION 4. MESSAGE COMPOSITION AIDS

Guidelines in this category bear on methods for enhancing user/operator capabilities for generating fixed-format and free text message elements. Two aspects of message composition are considered:

4.1 Alphanumeric Messages, or messages comprised wholly of alphanumeric characters.

4.2 Graphics Messages, or messages intending to convey pictorial or diagrammatic information.

4.1 FORMAT FOR ALPHANUMERIC MESSAGES

I. Areas of Application for Alphanumeric Messages Composition

1. Creation of fixed format messages (or elements of messages which have a fixed format).

2. Creation of semi-fixed format messages (or elements of messages which have a partially fixed format).

3. Creation of free-text messages (or elements of messages which entail free text input).

II. Methods for Composing Alphanumeric Messages

1. Direct entry of message labels and content.

2. Form filling, with message label prompts.

3. Linked menus.

4. Form filling with linked HELP files.

III. Factors Influencing the Applicability of Methods for Composing Alphanumeric Messages

1. Speed of transmission of message formats and other information from the computer to the user/operator terminal.

2. Amount of information to be entered into the messages.

3. Size of the terminal display.

4. Availability of multiple terminal displays or display areas.

5. Range of legal values for particular message elements.

6. Number of legal categories for particular message elements.

IV. Criterion Areas for Alphanumeric Message Composition

1. Error rates, as influenced by:

   a. Imperfect recall of legal entries for formatted and semiformatted messages.

   b. Typographical errors in entering fixed format message data.

2. System throughput rates, as influenced by:

   a. Time to look up legal values information in system reference documents.

   b. Time required to enter lengthy codes into the message.

   c. Time required to correct message data entry errors.

3. User frustration, as influenced by:

   a. Requirement to refer to system documentation for legal values information.

   b. Requirement to continually enter lengthy codes.

4.2 GRAPHIC MESSAGES

I. Areas of Application for Graphic Message Composition

1. Creation of maps and charts.

2. Creation of situation displays to be overlaid on existing maps and charts.

3. Creation of bar charts, histograms, frequency polygons, and other representations of quantitative relationships.

4. Creation of "free form" drawings and sketches.

II. Methods for Graphics Message Composition

1. Direct generation of graphics displays from information stored in data bases.

2. Direct generation of graphics displays from information entered by the user/operator at the alphanumeric terminal.

3. Entry of points on-line via stream digitization.

4. Entry of points and lines via point (and connected point) digitization.

5. Alteration of graphics displays via:

   a. Rubber banding.

   b. Pick and move.

   c. Plot search symbol identification.

   d. Keyboard entry of relative or absolute coordinates.

   e. On-screen sketching with:

      (1) Light pens and light guns.

      (2) Joysticks.

      (3) Trackballs.

      (4) Touch sensitive surfaces.

      (5) Digitizing pad hardware.

6. Graphics overlay separation.

III. Factors Influencing the Applicability of Graphics Message Composition Methods

1. Data communication rates within the information network.

2. Characteristics of the available graphics hardware.

3. Graphics cursor positioning accuracy requirements.

4. Resolution required in the resulting graphics display.

5. Experience of the users/operators in composing graphics messages.

IV. Criterion Areas for Graphics Message Composition

1. Error rates, as influenced by:

   a. Errors in positioning graphics cursor.

   b. Errors in direct data entry resulting in misplaced symbols and lines.

   c. Specification of inappropriate symbology in direct data entry.

2. System throughput rates, as influenced by:

   a. Time required to position desired symbols within the graphics display.

   b. Time required for direct keyboard entry of position and symbol identification information.

   c. Time required to correct errors in graphics data specification and positioning.

3. Message integrity, as influenced by:

   a. Misestimation of positioning of symbols or points on graphics displays.

SECTION 5. DATA RETRIEVAL ASSISTANCE

Guidelines in this category present methods for supporting user/operator interaction with system data bases. Two aspects of data retrieval assistance are considered:

5.1 Query Methods, dealing with ways in which users/operators may identify the characteristics of data base contents which they wish to review or alter.

5.2 Query Structure, relating to ways in which interaction with system data bases may be organized, structured, and sequenced.

5.1 QUERY METHOD

I. Areas of Application for Data Base Query Methods

   1. Single element, single identifier retrievals.

   2. Multiple element retrievals.

   3. *Conditional retrievals.*

II. Methods for Data Base Query

   1. Query languages.

   2. Natural language input.

   3. Menus.

4. Fill in the blanks forms.

5. Voice input query languages.

6. Voice input natural languages.

7. Cursor positioning dialogs.

8. Question and answer dialogs.

9. Query command files.

10. Query command macros.

III. Factors Influencing the Applicability of Data Base Query Methods

1. Number of different elements in the data base.

2. Number of elements in the data base permitting range specification in retrievals.

3. General experience of the users/operators in framing data base retrieval specifications.

4. Number of times the average query command is used per unit time.

5. Extent to which legal entries to particular data base elements are limited to a constrained categorical set.

6. Number of legal entries associated with categorical sets.

7. Characteristics of available terminal hardware.

8. Extent to which retrievals tend to be repeated without modification.

9. Extent to which retrievals tend to be repeated with only minor modification.

10. Amount of extraneous noise in the operating environment.

IV. Criterion Areas for Command Language Methods

1. Error rates, as influenced by:

    1. Failure to appropriately recall required retrieval command or data base content codes and terms.

    2. Unintended entry of non-disambiguable command strings.

    3. Attempting to work too fast to accommodate to clumsy retrieval specification methods.

d. Errors made in specifying redundant command strings.

2. System throughput rates, as influenced by:

   a. Time required to enter command strings.

   b. Time required to enter redundant command strings.

   c. Time required to redo retrievals which were erroneously specified.

   d. Time required to correct query string specification errors.

   e. Time required to work through lengthy lists when only a few retrieval options are desired.

3. User frustration, as influenced by:

   a. Requirements to work through lengthy lists of query options when only a few are desired.

   b. Requirements for continually entering redundant query strings.

   c. Requirement for continually looking up legal command and data element value strings in system documentation.

4. Informational integrity, as influenced by:

   a. Erroneous specification of command strings.

5.2 QUERY STRUCTURE

I. Areas of Application for Query Structures

   1. Dates.

   2. Times.

   3. Positions.

   4. Locations.

   5. Names (of personnel).

   6. Countries.

   7. Echelons.

   8. Forces and force codes.

9. Ranks.

10. Equipment identification.

11. Equipment classification.

12. Organizational elements.

13. Structures and installations.

14. Distances.

15. Changes in distance over time.

16. Bearings and orientations: relative, absolute.

17. Bounded continuous distributions.

18. Bounded discrete distributions.

19. Categories.

20. Free text.

II. Methods for Applying Query Structures

1. Subfield identification.

2. Automated translation or transgeneration of values.

3. Menu or prompt-driven translation or transgeneration of values.

4. Table lookup conversion of values.

5. Feedback of query intent.

6. Range specification.

7. Inclusion specification. (e.g., all of....).

8. Exclusion specification. (e.g., all except....).

9. Cluster specification.

10. Contingent combinations of elements.

III. Factors Influencing the Applicability of Query Structures

1. Extent to which the information in the data elements is typically or can be logically clustered into subfields or subelements.

2. Extent to which the information entered is sufficiently unique in format to permit automated classification.

3. Number of different ways in which the same information can be represented to the system (e.g., different formats for specifying dates).

4. Availability of peripheral memory space for table lookups.

5. Precision required in specification of quantitative data element values and ranges.

6. Number of items in data element categorization.

7. Allowable complexity of queries.

8. Extent to which categories fall into logical subgroupings.

IV. Criterion States for Query Structures

1. Error rates, as influenced by:

   a. User/operator mis-specification of legal but erroneous values in retrieval strings or commands.

   b. Requirements for entering information which is convertible or derivable from other information already stored in the computer.

   c. Retrieval specifications different in intent from that conceived by the user/operator.

2. System throughput rates, as influenced by:

   a. Time required for entry of data which is derivable from other information already stored in the computer.

   b. Time spent in looking up valid command and data entry codes in the system reference documentation.

   c. Time spent in correcting errors.

SECTION 6. GLOSSARIES

Guidelines in this category discuss methods for assuring consistency in and availability of terms, codes, and labels used in interaction with the ADP system. Four aspects of glossaries and their use are considered:

6.1 Standard Terms, dealing with sources and conventions for sets of consistent terminology to be employed in user/operator interaction with the ADP system.

6.2 Character Sets and Labels, indicating methods for assuring consistency in presentation and use of alphanumeric and graphic symbol sets.

6.3 Glossary Availability and Use, dealing with methods for assuring that appropriate terms, codes, abbreviations, and labels will be available to and consistently employed by users/operators.

6.4 Abbreviation and Coding, discussing principles for formulating and employing codes, abbreviations, acronyms, and mnemonics employed by users/operators for data and command entry.

6.1 STANDARD TERMS

I. Areas of Application for Standard Terms

1. Terminological consistency within process sequences.

2. Terminological consistency across process sequences.

3. Terminological consistency with hard copy input information.

4. Terminological consistency with external systems:

   a. Equipment descriptions and designations.

   b. Place names.

   c. Organizational descriptions.

   d. Echelon descriptions.

   e. Units of measure.

   f. Other.

II. Methods of Insuring Standard Terminology

1. Reference to external list of standard terms for system operating functions.

2. Consistency enforced by agreement among system developers.

III. Factors Influencing the Applicability of Techniques for Assuring Standard Terminology

1. Existence of external standards for terms to be employed in the system.

2. Extent to which terms displayed or to be entered exist in different system procedures.

3. Availability of sufficient display space for incorporation of standard terminology without resorting to excessively crowded or multipage displays.

IV. Criterion Areas for Standard Terminology

1. Error rates, as influenced by:

   a. Misunderstandings resulting from the use of nonstandard terms.

   b. Miscoding due to attempts to apply standard code or mnemonic formulation rules to nonstandardized terms.

2. System throughput rates, as influenced by:

   a. Time to interpret the meaning of nonstandardized terms.

   b. Time to correct errors.

6.2 CHARACTER SETS AND LABELS

I. Areas of Application for Character Sets and Labels

1. Presentation of text at the user/operator display.

2. Presentation of graphics symbols at the user/operator display.

3. Tagging or highlighting of textual or graphics elements.

4. Symbolic attribute encoding.

II. Methods for Standardizing Character Sets and Labels

1. Selection of terminals with identical character sets.

2. Use of software controlled character fonts.

3. Adherence to character formulation rules.

III. Factors Influencing the Applicability of Standardized Character Sets and Labels

1. Flexibility to acquire a standard user/operator terminal configuration.

2. Availability of software-definable character sets.

3. Availability of character generation options with sufficient flexibility to permit generation of characters in the form agreed upon for standardization.

4. Existence of conventions for labeling, attribute encoding, and highlighting with symbology.

IV. Criterion Areas for Character Sets and Labels

1. Error rates, as influenced by:

   a. Confusion of characters and labels required for data entry.

   b. Confusion of character sets and labels which are used to prompt data or command entry.

2. System throughput rates, as influenced by:

   a. Time required to interpret unfamiliar characters and labels.

   b. Time required to correct errors.

6.3 GLOSSARY AVAILABILITY AND USE

I. Areas of Application for Glossary Availability and Use

1. Assuring the use of standard terms in message composition.

2. Assuring the use of standard terms in data entry.

3. Assuring the use of standard terms in report generation.

II. Methods for Assuring Glossary Availability and Use

1. Presentation of standard term lists in system HELP files.

2. Appearance of glossary elements in menus and prompts.

3. Default incorporation of standard terms in report and message header and fields.

III. Factors Influencing the Applicability of Glossary Availability and Use

1. Existence of standard terms.

2. Use of standard terms in command and data entry contexts.

3. Number of terms potentially appropriate for particular command and data entry situations.

IV. Criterion Areas for Glossary Availability and Use

1. Error rates, as influenced by:

   a. Misunderstandings resulting from the nonavailability of glossaries at the user/operator terminal.

   b. Failure to use appropriate code terms for command or data entry.

2. System throughput rates, as influenced by:

   a. Time required to locate standard terms from glossaries.

   b. Time required to correct errors.

6.4 ABBREVIATION AND CODING

I. Areas of Application for Abbreviation and Coding

1. Decrease the number of keystrokes required for data and command entry.

2. *Conform* to existing terminological standards and conventions.

3. Decrease the amount of information to be presented on a given display screen or page.

4. Permit summarized information for scanning of information.

5. Permit labeling of charts and graphs.

6. Reduce data communications burden.

7. Mimic the appearance of hard copy forms from which data must be entered.

8. Condense hierarchically related information sets.

II. Methods for Abbreviation and Coding

1. Numeric coding.

2. Shape coding.

3. Color coding.

4. Coding by abbreviation:

   a. Significant consonants.

   b. Constant length mnemonics.

   c. Variable length mnemonics.

   d. Formulation of acronyms.

   e. First n character encoding.

5. Disambiguation menus.

III. Factors Influencing the Applicability of Abbreviation and Coding Methods

1. Availability of interaction hardware features.

2. Size of the set of information to be encoded.

3. Variability of initial characters in the terms and items to be encoded.

4. Available display space.

5. Familiarity of the users/operators with the terms which are being encoded.

6. Availability of abbreviation and code glossaries to the user/operator.

IV. Criterion Areas for Abbreviation and Coding

1. Error rates, as influenced by:

   a. Requirement to type in characters that are redundant in the information theory sense.

   b. Interference of the abbreviations and codes with others used by the users/operators.

   c. Misspellings occasioned by the requirement to type in lengthy and complex phrases as command or data entry.

   d. Difficulty in learning commands and data entry terms which have no intrinsic meaning to the users/operators.

2. System throughput rates, as influenced by:

   a. Time required to enter characters which are informationally redundant.

b. Time required to consult references which define the terms which are intrinsically meaningless to the user/operator.

c. Time required to correct errors.

SECTION 7. ERROR HANDLING

Guidelines in this category discuss methods for preventing and dealing with errors which may occur in user/operator interaction with the ADP system. Four aspects of error handling are considered:

7.1 Error Prevention, discussing techniques for assuring that errors are not committed by users/operators.

7.2 Error Detection, dealing with methods for identifying erroneous command and data entries before they can result in unnecessary system operations or degraded data holdings.

7.3 Error Feedback, bearing on how the user/operator should be alerted to the fact that errors have occurred, as well as what kinds of information about the errors should be displayed.

7.4 Error Correction/Recovery, indication methods for correcting errors which have been detected by the ADP system or the user/operator.

7.1 PREVENTION

Most of the techniques discussed in this document can be thought of as error prevention techniques. This discussion will focus on general approaches to error prevention which are not subsumed in other categories.

7.2 ERROR DETECTION

I. Areas of Application for Error Detection

1. Misspellings.

2. Entry of numbers outside of allowable ranges.

3. Use of illegal delimiter and terminator characters and codes.

4. Entering commands or data inconsistent with previously entered information.

5. Entering commands or data inconsistent with simultaneously entered information.

6. Entry of information in an invalid format.

7. Entry of commands in an invalid format.

8. Entry of commands in a legal but inappropriate sequence.

II. Methods for Error Detection

1. Range checks.

2. Checks against legal response tables.

3. Checks against format tables.

4. Checks for irrelevant or informationally optional command or data entry string elements.

5. Process sequence buffers.

6. Probablistic error checks.

7. User/operator verification.

8. Second party verification (key verification).

9. Sum checking.

10. Relational/dependency checks.

11. User/operator entry feedback.

12. Free text grammar and syntax checks.

III. Factors Influencing the Applicability of Methods for Error Detection

1. Availability of "intelligence" in the user terminal.

2. Possible delimitation of allowable ranges for data entry elements.

3. Number of valid responses to command or data entry prompt.

4. Criticality of certain types of errors.

5. Character set which is legal for command and data entry.

6. Freedom accorded user/operator to control the sequence and flow of system operations.

7. Availability of historical information on central tendency and dispersion of responses to particular data entry prompts.

8. Interdependency among separate data element records entered during a particular terminal session.

IV. Criterion Areas for Error Detection

1. Error rates, as influenced by:

   a. Errors which pass undetected through the command and data entry process.

   b. Extent of detection of "false errors" by sophisticated error trapping routines.

2. System throughput rates, as influenced by:

   a. Time required to correct errors.

   b. Time required for detailed review of user/operator data entry and procedures.

   c. Time required to correct the errors which remained undetected during original command or data entry.

   d. Time lost while undesired computer operations were being performed before errors in command entry were detected.

3. Informational integrity, as influenced by failure to detect user/operator errors.

7.3 ERROR FEEDBACK

I. Areas of Application for Error Feedback

1. Providing indications that an error was made by the user/operator.

2. Providing indications that an error was made by personnel other than the user/operator.

3. Providing indications that a hardware or software error has occurred.

4. Providing indications that some aspect of system capacity has been exceeded.

5. Providing indications that system resources are unavailable.

II. Methods for Providing Error Feedback

1. Numeric error codes.

2. Informative error messages.

3. Information on the erroneous string entered.

4. Information on the legal values associated with the command or data entry task which the user/operator was trying to perform.

5. Indications of the steps required to remedy the error.

6. Indications of what aspect of system operation was responsible for or associated with the error.

7. Use of defined error code areas.

8. Pointers to manuals and reference documents to accomplish error remediation.

9. Audible alarm.

10. High-visibility visual alarm.

III. Factors Influencing the Applicability of Error Feedback Methods

1. Availability of sufficient peripheral memory to store error codes.

2. Availability of sufficient peripheral memory to process detailed error feedback messages.

3. Size of the display area.

4. Capability for nondisruptive presentation of error messages.

5. Availability of stored legal values information.

6. Amount of information to be presented in the error message.

7. Variability of amount of information to be presented in the error messages.

8. Availability of procedures for correcting errors.

9. Noise in operating environment.

IV. Criterion Areas for Error Feedback

1. Error rates, as influenced by:

   a. "Second-generation" errors caused by unclear or misleading error feedback.

   b. Error correction errors caused by error correction procedures which are significantly different in form from the techniques used for command or data entry.

2. System throughput rates, as influenced by:

   a. Time required to interpret error messages.

   b. Time required to enter appropriate error correction commands and data by trial and error methods.

   c. Time required to locate error correction code interpretations in reference documentation.

   d. Time required to locate error correction procedures in system reference documentation.

   e. Time required to perform error correction using unfamiliar terminal operations.

   f. Time lost from processing while waiting for operator intervention necessary to correct system hardware and software errors.

7.4 CORRECTION/RECOVERY

I. Areas of Application for Error Correction/Recovery

1. Correcting errors made by the user/operator.

2. Correcting errors made by personnel other than the user/operator.

3. Correcting hardware or software errors.

4. Accommodating to exceeding system capacities.

5. Accommodating to unavailability of system resources.

II. Methods for Error Detection/Recovery

1. Representation of data or command entry prompt.

2. Automated generation of message to personnel who made the error.

3. Correction of erroneous data by cursor control keys following immediate indication of erroneous string entry in multi-element command or data entry strings.

4. Automatic movement of cursor to erroneous string portion.

5. Automated analysis and candidate presentation of command or data entry string most likely intended by the user/operator.

6. Stored sequences of operations for dealing with hardware failure/error, software error, or system resource limitation.

III. Factors Influencing the Applicability of Methods for Error Detection/Recovery

1. Availability of information on which person made an error.

2. Availability of communication channel to personnel or organizations responsible for the error.

3. Availability of sufficient information about the error to permit the current user/operator to correct it.

4. Availability of information on what other data are required to correct errors made by other organizations or personnel.

5. Intelligence of local terminal.

6. Loading of central processor; capability of central processor to continually monitor and evaluate user/operator input character-by-character.

7. Extent to which multiple commands are typically entered in a single command line.

8. Number of command or data entry options.

9. Similarity in command or data entry term content and format.

10. Amenability of system failures to correct from user/operator terminals.

IV. Criterion Areas for Error Correction/Recovery

1. Error rates, as influenced by:

a. "Second-generation" errors associated with error correction procedures which are inconsistent with other terminal operations.

2. System throughput rates, as influenced by:

   a. Time required to employ unfamiliar error correction procedures.

   b. Time required to decide what information is needed to correct the error.

   c. Time required to position cursor over long command string.

   d. Time required to correct second-generation errors.

SECTION 8. USER/OPERATOR CONFIGURATIONS

Guidelines in this category discuss arrangements of computer system users and/or operators which are most appropriate for given kinds of systems and tasks within systems.

I. Areas of Application for User-Operator Configurations

   1. Entry of data from preprinted forms.

   2. Entry of data from telephonic and verbal communications.

   3. Transactional data base maintenance.

   4. Creation and maintenance of tactical situation displays.

   5. Performance and monitoring of complex quantitative calculations.

   6. Message creation.

   7. Message entry.

   8. Message queue maintenance.

   9. Message interpretation.

   10. Retrieval from complex data base structures.

   11. Monitoring of tactical situations.

   12. Creation of complex operational plans.

   13. Monitoring of geographically widespread situations.

   14. Report generation.

15. Report production.

16. Command consultation and decision.

17. Establishment of system networks.

II. Methods for Configuring Users/Operators

1. Operators only.

2. Operator(s) and user(s).

3. Combined user/operator.

4. User and operator networks and chains.

III. Factors Influencing the Applicability of User/Operator Configurations

1. Extent to which use and operation of the system required operational experience which can be attained only through months or years of exposure to military situations.

2. Sophistication required for interpretation of input to the system.

3. Sophistication required for message generation.

4. Extent to which required data base retrievals are describable to other personnel.

5. Existence of standard report formats.

6. Requirements for *ad hoc* report formatting and content specification.

7. Available physical space for users and operators.

8. Presence of communications devices capable of linking users and operators.

9. Probable levels of noise and other distractions in the operating environment.

IV. Criterion Areas for User/Operator Configurations

1. Error rates, as influenced by:

a. Difficulty in communicating among users and operators in the operating environment.

b. Failure of communication systems.

c. Increased likelihood of error when the user and operator networks are disrupted.

d. Reaction of personnel to decision burdens.

e. Inexperience of personnel with the capabilities of the system.

f. Inexperience of personnel with the command structure and techniques associated with the system.

g. Inexperience of personnel with the data base and data base query structure and methods of the system.

2. System throughput rates, as influenced by:

a. Time required to make clear the intent of system instructions and desired operations.

b. Wasted time resulting from communication degradation.

c. Time required for inexperienced operators to enter commands and data into the system.

d. Time required to correct errors.

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